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THE SOUTH OCEAN AND ANTARCTICA ACCORDING TO GRAVIMETRIC DATA,(U)

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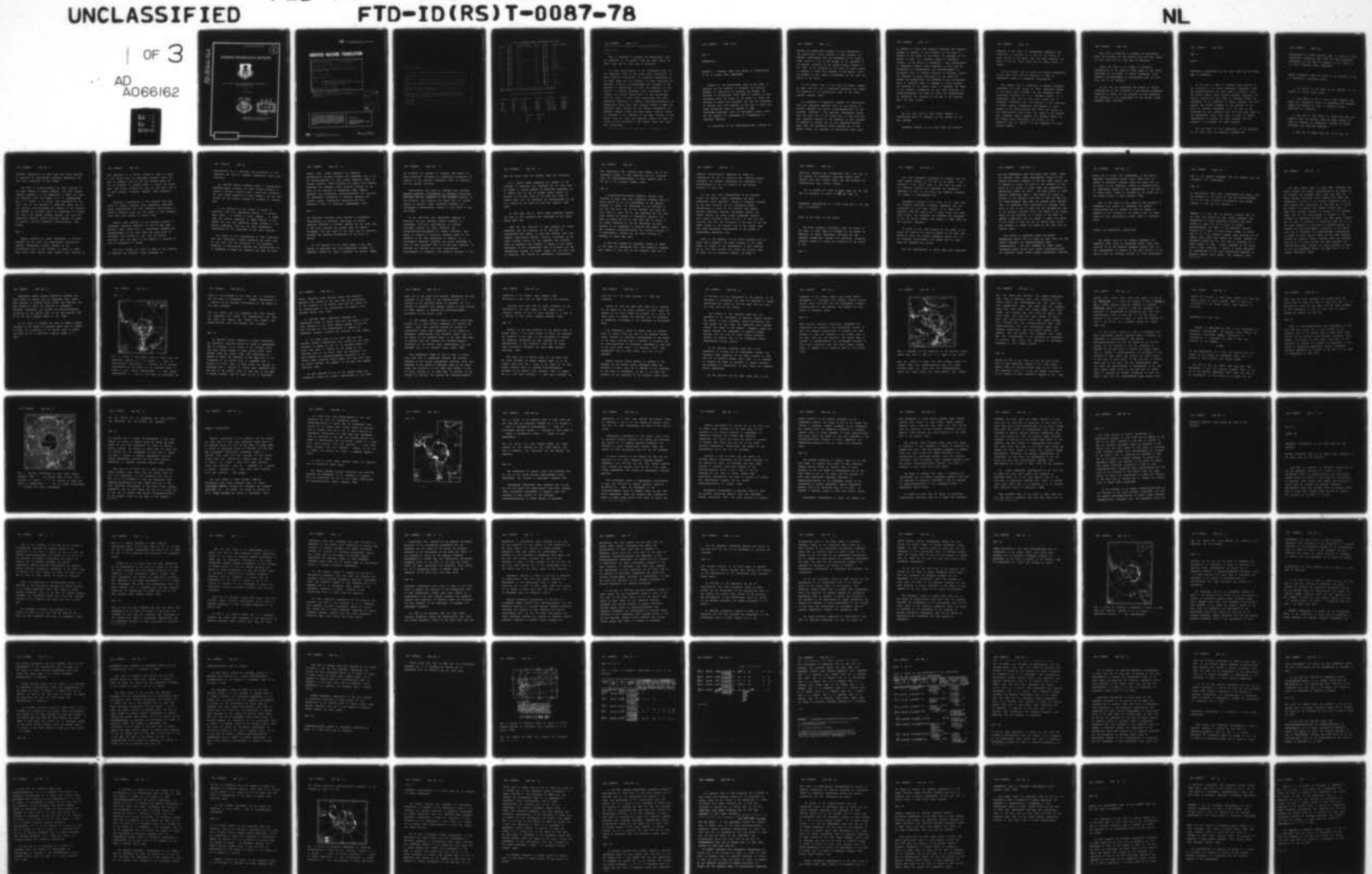

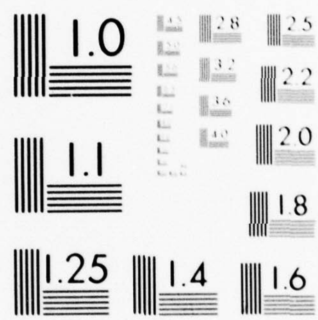

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THE SOUTH OCEAN AND ANTARCTICA ACCORDING TO
GRAVIMETRIC DATA

by

P. A. Stroyev

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FTD- ID(RS)T-0087-78

UNEDITED MACHINE TRANSLATION

FTD-ID(RS)T-0087-78 23 February 1978

MICROFICHE NR: FTD-78-C-000265

THE SOUTH OCEAN AND ANTARCTICA ACCORDING TO GRAVIMETRIC DATA

By: P. A. Stroyev

English pages: 241

Source: Yuzhnyy Okean i Antarktika po Gravimetricheskim Dannym, Izd-vo "Nauka", Moscow, 1972, pp. 1-105.

Country of origin: USSR
This document is a machine translation.

Requester: DMAAC/SDDL

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

THE SOUTH OCEAN AND ANTARCTICA ACCORDING TO GRAVIMETRIC DATA.

P. A. Stroyev.

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Work is dedicated to research on gravitational field and structures of the earth's crust and upper mantle of south ocean and the limb zone of antarctica.

Is given survey/coverage of the contemporary state of the geophysical study of the region being investigated. Is given detailed characteristic of gravimetric measurements in the south ocean and the Antarctic. Is given description of equipment, procedure of photographing and treatment of the materials of observations; is given the evaluation of the accuracy of obtained gravimetric data. Considerable place occupies the detailed characteristic of the gravitational field of region of earth being investigated; are given gravimetric map/charts; is examined communication/connection of gravitational field with other physical fields; is made the conclusion about isostasy and the density heterogeneity of substance suppress crusts and upper mantle. Separate chapter is dedicated to the questions of the deep structure of the earth's crust of ocean and transition region; is given the circuit of the thickness of the earth's crust, are given some cut/sections.

Tables - 3. References - 105 titles. Illustrations - 24.

Page 3.

INTRODUCTION [1].

FOOTNOTE [1]. Monograph lights the results of investigations as of on January 1969. ENDFOOTNOTE.

Research on the gravitational field of the Earth is necessary for the solution of scientific and practical problems. In application to astronomy and geodesy, the knowledge of gravitational field makes it possible to draw conclusions about the figure of the Earth, to obtain the deviation of geoid from ellipsoid, and also the deviations of vertical line. The knowledge of the form of geoid and plumb inclinations makes it possible to base cartographer-topographic works on astronomical points, which for the regions, not encompassed by triangulation, is especially important.

In application to the common/general/total problems of

geology and geophysicists research on the distribution of the gravitational field, connected in many instances by specific relationships with the structures of the earth's crust, serves as one of the methods of the knowledge of the geologic structure of the studied region. Research on the field of the anomalies of the force of gravity makes it possible to judge the thickness of the Earth's crust, the presence of the density heterogeneity of the crust and mantle of the Earth.

At the present time, in the epoch of intense research on space with the aid of artificial satellites and rockets the knowledge of the gravitational field of the Earth acquires important value.

In application to antarctica, research on gravitational field has especially important value on the strength of specific character and special feature/peculiarities of this continent. Antarctica - the continent, continuously covered with ice; only 5o/o of its entire area is free from ice land. Therefore research on the structure of this continent is possible in essence only by the geophysical methods among which the gravimetric method occupies one of the leading places. The knowledge of gravitational field makes

it possible to solve many important scientific and practical problems of research on the antarctic. In the sense of research on the figure of the Earth, the knowledge of the surface of geoid in c antarctic region is especially valuable. In the region of cartography - this substantiation of topographic mapping. Since antarctica is torn from the grid/network of triangulations, the interrelationship of topographic works on enormous territory is impossible without the knowledge of plumb inclination. In the region of geology and geophysicists the knowledge of the gravitational field of antarctica makes it possible to study structure and thickness of the Earth's crust, to determine the degree of the isostatic compensation for the sixth continent, to reveal/detect/expose the zones of faults and disequilibrium, to investigate the structure of the bed of the bedrocks, which lay under glacier.

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For the water area of south ocean, research on gravitational field is necessary for the solution of the same problems.

Systematic research on the south ocean and antarctic

beginning in the period of international geophysical year (1956-1958) is continued up to now. In the studies of these regions of the Earth, take part many countries, and first of all the Soviet Union and the United States of America.

At the present time by Soviet and foreign geophysicists in the south ocean and the antarctic is made the considerable volume of gravimetric investigations.

The dominant role in conducting of maritime gravimetric measurements in these regions by Soviet expeditions belongs to the moscow state university and the especially State astronomical institute im. P. K. Sternberg (GAISh). In 15 summer/years, from 1955 on 1969, GAISh carried out 11 gravimetric expeditions into the antarctic in the composition of Soviet antarctic expeditions, participating in eight voyages of the diesel-electric ship "Ob'", one voyage of the diesel-electric ship "Lena", one voyage of the research ship "Professor Zubov". Together with geologic faculty of MGU [Moscow State University], was carried out the expedition into the antarctic in the composition of whale flotilla "Slava".

This work is dedicated to research on gravitational field and structures of the earth's crust and upper mantle of south ocean and the limb zone of antarctica.

Author took part in all stages of gravimetric investigations of the GAISh in world ocean, he was direct participant or the leader of several expeditions, which conducted the measurements of gravitational force in south ocean and in the antarctic.

In the work are generalized the results of 15-year investigations of the collective of the maritime gravimetric expedition of GAISh. To all coworkers of this expedition, and especially to the participants of the cruises, author expresses heart gratitude.

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Chapter 1.

GEOPHYSICAL INVESTIGATIONS IN THE SOUTH OCEAN AND THE FRINGE ZONE OF ANTARCTICA.

By the name of South or Antarctic Ocean recently on the initiative of the Soviet researchers (Treshnikov, 1967) are separate/liberated the south parts of Atlantic, Indian and Pacific Oceans, which surround continent antarctica. The northern boundary of south ocean is conducted through the extremities of the continents of Africa, Australia and south America. The northern boundary of the antarctic is the front of antarctic convergence, i.e., the zone of the convergence of cold antarctic water with more warm water of the subantarctic. Thus, south ocean on north is limited approximately to parallel 30° south latitude, and the antarctic - by parallel 50° south latitude.

For the latter of 10-15 summer/years of the experiment of the south ocean and antarctic, exceeded the

investigations of entire preceding time. In period and after international geophysical year (IGY) the very considerable contribution to the cause of research on this region of the Earth introduced Soviet researchers.

General information about the study of the antarctic of up to international geophysical years.

In the history of the study of the antarctic, it is possible to outline three stages.

1. From middle of 8th to end of 19th centuries was opened and investigated series of subantarctic and antarctic islands and sections of coast of continent without debarcation of antarctica.

2. From end of 19th century to Second World War, was conducted study of antarctic seas and small sections of coasts of continent by expeditions, organized by private individuals and scientific societies.

3. From end of Second World War up to now, is

conducted investigation of south ocean and entire continent of antarctica by international scientific expeditions, and also large expeditions of some states.

The honor of discovery/opening the sixth continent of the Earth belongs to Russian seafarers. The first Russian antarctic expedition in the composition of sloops the "east" and "peaceful" under the command of F. F. Bellingshausen and M. P. Lazarev on 28 January 1820 approached for the first time the ice continent of antarctica. Before end of 19th century, discovery/opening and research on the antarctic was realized by accidental ships and expeditions. In essence this were trade vessels (whalers, sealers). And only rare expeditions conducted special scientific research of shores of antarctic continent (expedition Dumont-d'Urville, Ross, Wilkes).

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English expedition on vessel "Challenger" in 1872-1876 conducted for the first time comprehensive investigations (physical oceanography, biology, geology) in the circumlittoral part of the continent in region of Wilkes Land, Adelie Land, Victoria Land. Geologic data, obtained in

this expedition by J. Murray, allowed it final to arrive at the opinion that the south-polar continent exists not only as formation from ice and the separate Earth, but also as continent in geologic sense. J. Murray drew around south pole single continent and gave for the first time to it name "antarctic continent" (Lebedev, 1963; Treshnikov, 1963).

Interesting investigations in the antarctic were made during K. Larsen's Norwegian whale expeditions (1893-1925). Larsen reveal/detected the first fossilized petrifications in antarctic peninsula. This were the pieces of the coniferous trees which were related to tertiary time.

People's first onslaught to ice continent produced L. Kristensen's Norwegian expedition in 1894 of Cape Adare (Victoria Land). During this, C. Borchgrevink assembled the specimen/samples of the rocks which had large value for geologists, who discussed at that time the question concerning that, are there in the antarctic a continent or only an archipelago of islands.

The first 13-month ice drift in water of the antarctic it completed the scientific vessel "Belgique" in

Bellingshausen Sea in 1897-1898. The participant of this expedition was young R. Amundsen, subsequently famous polar researcher.

In 1898-1900 English expedition under C. Borchgrevink's management/manual organized the first 9-month wintering on antarctic continent (Victoria Land). During this expedition was made sleigh expedition to south magnetic pole and were carried out the geologic analyses of mountains of Victoria Land.

In the beginning of 20th century to shores of antarctica, went four expeditions: British - to Victoria Land, German - to Wilhelm II Coast, Swedish - to Graham Land, and scottish expedition on vessel "Scotia" to the Weddell Sea. All four expeditions worked according to the matched plan/layout. This was the first international collaboration of the researchers of the sixth continent.

The results of the investigations of these expeditions were very considerable. British expedition (R. Scott) gave for the first time the description of the Precambrian foundation of East-antarctic platform and lying/horizontal on it sedimentary thickness was sandstone the suite of Bikon

(Ferrar, 1907). German expedition (E. Drygalski) open/discovered Gaussberg Mountain and established that it is the residue/remainders of young volcano (Reinisch, 1906). In morainal deposits, besides granites and gneiss, were detected sandstones and limestone, which indicates existence in the depth of the continent of sedimentary rocks. Swedish expedition (O. Nordenskjold) establish/installed the structural and petrographic resemblance of antarctic peninsula and adjacent islands. Nordelskjold constructed the first geotectonic circuit of antarctica (Nordenskjold, 1913).

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The expeditions described above initiated to geophysical investigations in antarctica. Participant of British expedition 1898-1900 L. Bernakey recorded for the first time on the sixth continent the seismic waves of distant earthquakes. The very same for the first time in antarctica fulfilled the pendulum determinations of the force of gravity.

In the beginning of the second decade of the 20th century in antarctica went five expeditions: Norwegian (R. Amundsen), English (R. Scott), Australian (D. Mawson), German

(W. Pilchner) and Japanese (C. Shirase). The results of these expeditions introduced the significant contribution to research on the continent (especially coast) of antarctica and its geologic structure.

Simultaneously with works on continent were conducted maritime scientific investigations in hydrology, meteorology, glaciology and marine geology. In 1925 began the systematic English the expedition of the Discovery Committee in the antarctic. This Committee was placed with its problem mapping of antarctic coast, conducting biological and oceanographic investigations, research on the relief of the sea bottom.

In the 1920-1930's four expeditions, conducted in antarctica the very extensive studies: Norwegian (L. Christensen, 1929-1937), Anglo-American (H. Wilkins, 1928-1929), American (R. Byrd, 1928-1930) and British-Australian-New-Zealand (D. Mawson, 1929-1931). This period of research on antarctica signifies itself by the beginning of the wide application of aviation. So, L. Christensen's expedition conducted the aerial photography of coast of east antarctica from 22 to 83° east longitude. In 1933-1935 was completed the first trans-Antarctic flight/passage (L. Ellsworth) from antarctic peninsula to the

Ross Sea during which the Sentinel Range was discovered.

In R. Byrd's second expedition for research on the structure of antarctica, was undertaken for the first time an attempt to utilize methods of exploration geophysics. T. C. Poulter with the aid of seismic survey refined the position of the east coast of the Ross Sea, which is located under ice, and determined the power/thickness of ice in a series of the points of this sea (Poulter, 1939, 1947).

In 1938 began work R. Byrd's third expedition. However, the work of this expedition was interrupted by the begun Second World War.

After war into 1946-1947, R. Byrd organizes his fourth expedition into the antarctic. In it took part of approximately 4400 people, of them 4000 military. Were used powerful cross-country vehicles, aviation, ice-breaker of law court, aircraft carrier and the submarine. The scientific works of expedition were reduced in essence to the aerial photography of the circumlittoral zone of continent and the hydrophysical analyses of coastal waters. For the first time in antarctica were carried out aeromagnetic investigations.

With magnetometer were completed four flights. One of the interesting results of this expedition was the conclusion about the displacement/movement of south magnetic pole on 270 km to the northwest (Sholes, 1953).

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A Norwegian-British-Swedish expedition wintered into 1949-1952 at Queen Maud Land. Expedition conducted works in radius 600-700 km on the investigation of the geologic structure of region, the measurement of the thickness of ice (for the first time on ice continent were made the drill holes to depth 100 m). The expedition was the first, which applied the methods of exploration geophysics [of route by length 600 km was made more than 50 points of the seismic soundings of ice for explaining the basic features of the morphology of under-ice bed (Robin, 1964)]. This expedition establish/installed the two-level structure of an east-antarctic platform and the block structure of mountains of Queen Maud Land.

In 1954 was created the Australian station of Mawson on the shore of MacRobertson Land. This expedition inspected many regions of this part of the antarctic coast and it

completed intracontinental expedition by extent of approximately 650 km. In expedition were conducted seismic, gravimetric and magnetic observations for determining the power/thickness of ice and research on the geologic structure of stone bed.

At this time their investigations in the antarctic conduct the English, French, Argentinean and Chile expeditions, which organized a series of scientific stations on the sixth continent and the surrounding islands. Simultaneously in water of the antarctic work several maritime expeditions (American ice-breakers "Edisto" and "Burton Island", the French vessel "Commandant Charcot", Chile vessel "President Pinto" et al.). In 1954 into the antarctic, was sent the ice-breaker of the navy of the USA "Atka" (worker in the antarctic and by the present time), that began preliminary investigations in the program of international geophysical year.

Thus, at the beginning of the 1950's antarctica was no longer Terra incognito. The sixth continent of our planet became the subject of the investigation of many countries, and by this time narrower were formed the specific views on nature and its structure. However, the study of

antarctica concerned only circumlittoral part. Limb zone on the strength of geographical conditions (mainly small distance from basic coastal bases) was more available for investigations, than internal regions.

Let us examine the study of south ocean and the limb zone of antarctica in period of MGG IGY and after it.

Geophysical investigations in a south ocean and in the limb zone of antarctica.

Study of the relief of the bottom.

The first systematic information about the relief of the floor of south ocean is contained in the reports of expedition on vessel "Challenger" 1872-1876. All the subsequent expeditions, equipped into antarctica, constantly conducted research of depths and morphology of the bottom of sea.

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The first bathimetric map/charts of antarctic seas and their regions appeared at the end of the 1920's - the beginning of the 1930's. Thus, in 1930 from the works of the Discovery Committee were comprised the bathimetric map/charts of area of the Scotia Sea, antarctic peninsula, the islands of Bellingshausen Sea.

Subsequently research on the relief of the ocean floor was developed sufficiently intensely, especially with the introduction of sonic depth finders. In R. Byrd's 4th expedition 1946-1947 aboard all 13 ships, there were sonic depth finders, and constantly was conducted the measurement of the sea bottom. However, the results of these works are only partially published.

In period of IGY, wide research on the relief of the bottom was conducted by research vessels of the USSR, USA, Australia, Japan, New Zealand, Argentina, France, etc. of the countries. Unfortunately, the results also of these works are published very slowly.

From the investigations of recent years most significant

are the measurements, made from ships "Ob'" (USSR), "Vima" and "Eltanin" (USA). These investigations because of the obtained continuous recording of the echo sound signals made it possible to reveal the parts of the structure of the bottom in all sectors of south ocean. The measurements of expeditionary vessel the "Ob'" - the flag officer of Soviet antarctic expeditions (SAE) - only during the period of floating in the antarctic from 1955 on 1963 are made for the extent/elongation more than 150 thousand miles (Zhivago, 1967). An especially dense grid/network of surveying tacks falls on area of sea of Davis and the circumlittoral part of the antarctic continent within the limits of the Indian sector of the antarctic. As a result of the works of American expeditions, very is studied in detail the relief of the bottom at Ross Sea and in Pacific Ocean sector. Less detailed is studied the bottom of the south part of Atlantic Ocean.

The studies of underwater relief and benthic sedimentation showed that the floor of south ocean has very complex structure. Are separate/liberated basic morphostructures - the vast complexes of relief (shelf, continental slope, island arcs, oceanic swell/rampart/rises and underwater ridges, median oceanic spine/ridges, deep-water

basins and so forth), the corresponding to the specific structural cell/elements earth's crust. These forms are created by endogenous processes within the upper part of the Earth. On the background, created by morphostructures, are superimposed smaller in the size/dimension of the form of bottom relief, caused by processes on the bottom and in the aqueous medium of ocean (Zhivago, 1967).

Data on the relief of the bottom of the antarctic in conjunction with results of geophysical and geologic investigations make it possible to make an attempt at research on the structure of the earth's crust and upper mantle of this insufficiently studied region of terrestial globe.

Seismic and seismological observations.

The seismic study of the Southern Hemisphere and especially south ocean is considerably worse, rather than northern. If in the Northern Hemisphere seismic works for the target/purpose of research on the deep structure of the earth's crust are conducted narrower for 20-25 summer/years,

then in the Southern Hemisphere they are conducted only for last/latter 10-15 summer/years.

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In near-Antarctic water these investigations are absent, with the exception of the Scotia Sea and the Southern-Antilles arc. On the very continent of antarctica, deep seismic sounding to 1969 was not conducted [1].

FOOTNOTE [1]. In May 1969 on antarctic continent were for the first time carried out deep seismic soundings. The geophysicists of NIIGA (Leningrad) fulfilled them along profile by length 430 km in region of station Novolazarevskaya. The depth of the Mohorovicic surface, obtained as a result of these works, changes on profile from 27 to 42 km, moreover revealed block structure of the earth's crust. These data confirm the results, obtained by gravimetric method for the limb zone of antarctica (A. L. Kogan. Results of deep - seismic soundings of the earth's crust in East Antarctica. - Reports of Soviet geologists and geophysicists at the II-nd International Symposium on Antarctic geology. Oslo, August, 1970, Leningrad, 1970. ENDFOOTNOTE.

The first seismic works in south ocean, obviously, one should consider the seismic investigations by the method of the reflected and refracted waves, made into 1959. By Lamont geologic observatory (LGO) together with Woods Hole oceanographic institute on the western continental slope of south America from Buenos-Aires to Cape Horn and at Scotia Sea between the Falkland and Sandwich Islands (Fig. 1). Works were conducted according to program of IGY (Woollard, 1960). Here for the target/purpose of research on the structure of sedimentary thickness, are made several profiles one of which is stretched on continental shelf from 35 to 57° south latitude. To the south of Falkland Islands, is obtained the full/total/complete cut/section of the earth's crust and is determined its power/thickness. Investigations in region of South Georgia Island and the South Sandwich Islands are connected several profiles, which are stretched from 48 to 57° south latitude and which intersect the South-Antilles Ridge. Although the total thickness of crust is not here determined however the upper part of it is studied sufficiently fully.

Subsequently Lamont geologic observatory conducted the large volume of seismic work in Argentinean basin. Works were fulfilled on research vessel "Vima" into 1961-1963. Was here studied in detail the structure of sedimentary thickness, furthermore, was obtained the full/total/complete cut/section of the earth's crust on the 45th parallel from 48 to 63° west longitude (Ewing et al., 1964).

In the Strait of Magellan are made 22 seismic stations according to the method of refracted waves. Here is studied in detail the cut/section of the earth's crust at entire its depth of up to Mohorovicic boundary (Ludwig et al., 1965).

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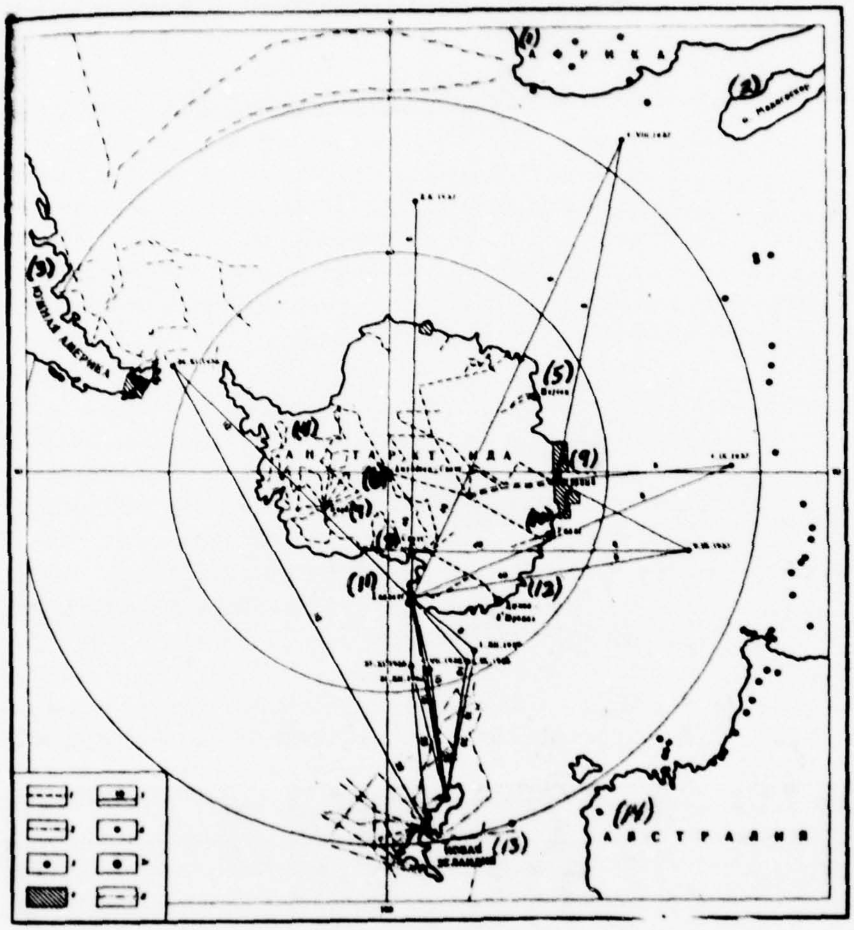

Fig. 1. Circuit of the seismic study of south ocean and antarctica. Compiled by P. A. Stroyev. 1 - route of inner-Antarctic expeditions; 2 - profiles of the maritime investigations by the method of the refracted waves; 3 - points of point seismic investigations; 4 - area seismic investigations; 5 - route of the waves of earthquakes and

value of the thickness of the crust, km; 6 - epicenters and the dates of earthquakes; 7 - seismic observatories; 8 - profiles of the maritime investigations by the method of the waves reflected.

Key: (1). Africa. (2). Is. Madagascar. (3). South America. (4). Antarctica. (5). Mawson. (6). Amundsen-Scott. (7). Byrd. (8). Scott. (9). Mirnyy. (10). Wilkes. (11). Hallett. (12). Dumont-d'Urville. (13). New Zealand. (14). Australia.

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In 1962-1963 English expedition on ships "Schackleton" and "Protector" fulfilled profile by length of approximately 2000 km according to the method of the refracted waves from South Orkney Islands to South Georgia Island south through Scotia Sea (Allen, 1966). Here sufficiently is studied in detail the structure of the upper part of the cut/section of the earth's crust to boundaries with a velocity of 5.7-6.2 km/s. In three points are obtained the boundaries with a velocity of 7.6-8.0 km/s, identified with the base of the earth's crust. At this time it was made 5 seismic profiles, each by length 30 km, in Bransfield

Strait, separating South Shetland Islands from antarctic peninsula. The purpose of the work were the determination of the structure of the earth's crust and the control of the interpretation of the gravitational and magnetic data, obtained earlier (Cox, 1964).

In 1962-1965 Lamont observatory fulfilled the considerable volume of seismic work with the method of the waves reflected in the south Atlantic between 18 and 40° south latitude for the target/purpose of research on sedimentary covering, structure and tectonics of this region.

In the Indian Ocean to the south from the 30th parallel, seismic investigations were carried out into 1959 according to program of IGY. At the southeast shores of Africa were taken 12 stations by the method of the refracted waves on the ships "Vima" and "Vraystat". Was here obtained the full/total/complete cut/section of the earth's crust. Typically mantle speeds 8.10 km/s were fixed at certain stations (for example, to the east from Durban) (Woollard, 1960).

In 1960 coworkers of LGO on the vessels "Vima" and "Diamantina" carried out seismic investigations in the Perth

Basin and to the south from Adelaide. Observations are made according to the method of the refracted waves on 8 profiles of the south-west shores of Australia and to 3 profiles to southwest from Kangaroo Island. On some sections in these regions, is obtained the full/total/complete cut/section of the earth's crust.

In 1962 seismic works of shores of south Africa were carried out by South African researchers to research ship "Natal'". Works were fulfilled through the program of international Indian Ocean expedition. In the complex of geophysical investigations, were conducted seismic works on the method of the refracted waves. In all were made about 20 stations. Was here obtained the full/total/complete cut/section of the earth's crust. Unfortunately, data are published only on two stations (Green, Hales, 1966).

The considerable volume of work is made in Indian Ocean into 1962 in expeditions "Monsoon" and "Luziad", organized by the Scripps Oceanographic Institute. Works were conducted by the method of refracted waves on the ships "Argo" and "Gorizont". On the water area between 30 and 40° south latitude, it is made about 15 stations. On the majority of stations, was obtained the full/total/complete

cut/section of the earth's crust (Riedel, 1964). Unfortunately, basic part of these data is not published.

Analogous works were made by Soviet scientists in the 1964-1965th in the 36th voyage of the research ship "Vityaz'". Between 30 and 40° south latitude it is made of 6 stations of deep seismic sounding (Udintzev, 1966).

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Research on the deep structure of the earth's crust by seismic method in the south regions of Africa and Australia was conducted on the basis of the utilization of special and industrial explosions. Are here obtained the total power/thickness of the terrestrial crust and in certain cases cut/sections throughout the whole depth (Gurariy, Solov'yeva, 1963).

The south part of Pacific Ocean (to the south from 30° south latitude) by seismic methods almost in no way studied. Here there are a total of two points of the deep seismic sounding where is obtained full/total/complete thickness of the Earth's crust (Officer, 1955): in Tasman Sea (ϕ = 40° south latitude, λ = 160° east longitude) and

Fiji Sea (ϕ = 30° south latitude, λ = 162° east longitude).

During May 1966 LGO made about 15000 km of profiles by the method of the waves reflected in water around New Zealand on the ships "Vima" and "Conrad". As a result of these works, is studied the structure and the propagation of sedimentary thicknesses in the structures of New-Zealand basin.

The considerable volume of seismic work in antarctic water of Pacific Ocean was made on the American nuclear vessel "Eltanin" in 1965-1966. Investigations in the method of the waves reflected made it possible to establish that the power/thicknesses of sedimentary thicknesses in this part of the south ocean reach 1 km (Heirtzler, 1967). More comprehensive data on these works, until now, is not published.

Besides precise seismic methods of research on the structure of the earth's crust, information about the thickness of crust, they can be obtained on the recordings of the waves of earthquakes. On Fig. 2, is given the map/chart of the seismicity of the antarctic during period

of 1910-1960. For the construction of the map/chart of the epicenters of earthquakes, are used the materials of seismic observations for period of IGY and later, and also more all known data on this region.

The analysis of this map/chart shows that the epicenters of the earthquakes of Antarctic seismic belt/zone are adapted to young underwater folding uplift/rises. The most seismic are the Scotia arc (especially South Sandwich Islands) and region of New Zealand - Macquarie Island and Balleny Islands. The coincidence of antarctic seismic belt/zone with the ring of Alpine folding structures confirms the presence here of the contemporary sharply differentiated tectonic motions.

On the antarctic continent, until now in all probability is recorded not one earthquakes. However, the conclusion about seismicity of the sixth continent to draw thus far is premature (Kogan, etc., 1965). It is necessary to increase the number of stations, to improve equipment and procedure of observations. In other words, are necessary further observations.

For the antarctic and the south ocean, data on the

dispersion of the surface waves, which appear during earthquakes, are determined from antarctic stations Mirnyy, Hallett, Scott, and also from the seismological stations, arrange/located in south America, New Zealand and other places of terrestial globe.

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These stations constantly record/write earthquakes and communicates the results to the international centers of data. The combined interpretation of observed data made possible to study the character of the earth's crust in the south ocean and the antarctic. This method makes it possible to establish/install the average/mean thickness of crust along oscillation loop with error ± 10o/o, moreover result it depends on the predicted model of the earth's crust.

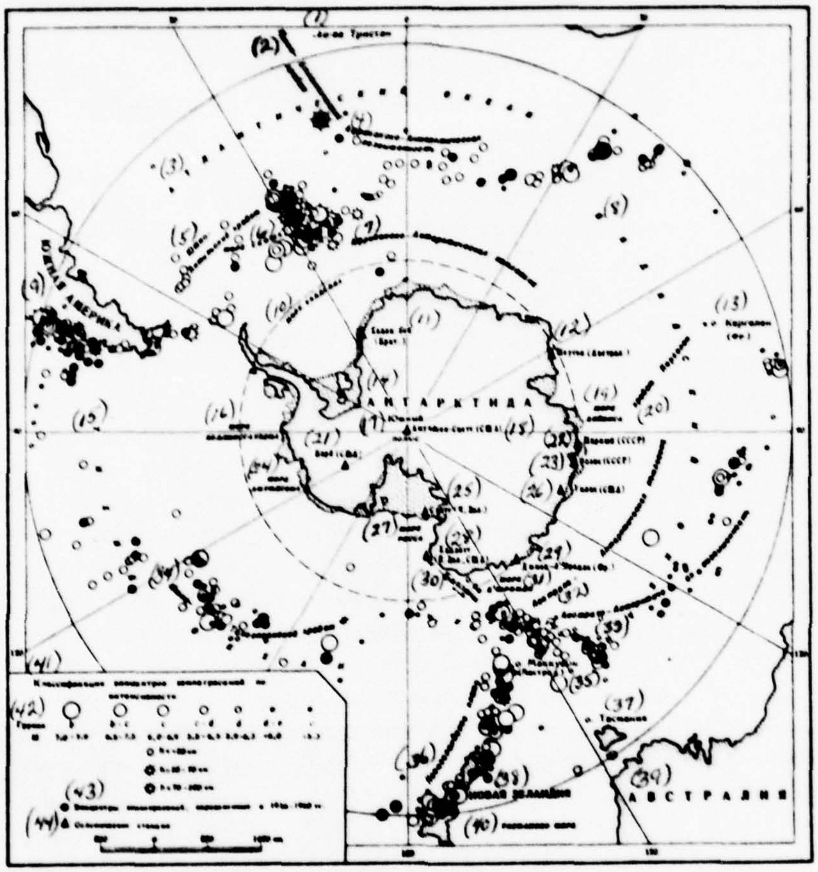

Fig. 2. Map/chart of the seismicity of the antarctic during period from 1910 on 1960 (on S. D. Kogan et al., 1965).

Key: (1). Tristan da Cunha. (2). South Atlantic Ridge. (3). Atlantic Ocean. (4). African-Antarctic rise. (5). South Antilles Ridge. (6). Scotia Sea. (7). African-Antarctic basin. (8). Indian Ocean. (9). South America. (10). Weddell

Sea. (11). Halley Bay (British). (12). Mawson (Australian). (13). Isles de Kerguelin (Fr.). (14). Antarctica. (15). Pacific Ocean. (16). Bellingshausen Sea. (17). South pole. (18). Amundsen-Scott (USA). (19). Davis Sea. (20). Kerguelin Ridge. (21). Byrd (USA). (22). Mirnyy (USSR). (23). Oasis (USSR). (24). Amundsen Sea. (25). Scott (N. Zeal.). (26). Wilkes (USA). (27). Ross Sea. (28). Hallett (N. Zeal., USA). (29). Dumont-d'Urville (Fr.). (30). Balleny Islands. (31). D'Urville Sea. (32). Australo-antarctic basin. (33). Australo-Antarctic Rise. (34). South-Pacific Ridge. (35). Macquarie (Australian). (36). New Zealand plateau. (37). Tasmania. (38). New Zealand. (39). Australia. (40). Tasman Sea. (41). Classification of the epicenters of earthquakes in intensity. (42). Group. (43). Epicenters of earthquakes, determined v. (44). Seismic stations.

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Because of this on the basis one and the same initial data by some researchers (Evison et al., 1960, Press, Dewart, 1959) was obtained average power of the crust of east antarctica, equal to 35 km, and Western antarctica - 25 km, whereas by other researchers (Bentley et al., 1960;

Bentley, 1964; Kovach, Press, 1961) with respect 40 and 30 km. Nevertheless as a whole the analysis of wave dispersion P_g and L_g, which intersect antarctic continent in different directions, makes it possible to make the conclusion that antarctica is characterized by continental type crust with power/thickness 35-40 km (see Fig. 1). For the oceanic sections of the routes of waves, is given the thickness of crust 5 and 10 km, i.e., thickness typical for oceanic type crust.

The more careful analysis of data of seismology with their considerable quantity sometimes makes it possible for researchers to establish/install some special feature/peculiarities of crust and mantle of the specific regions. So, the analysis of the wave dispersion of Rayleigh in the east parts of Pacific and Indian Oceans made it possible to establish/install the difference in the structure of upper mantle near Pacific and Indian Oceans. In the layer of upper mantle in the east part of Pacific Ocean, must be the layer with the lowered/reduced speed (7.8 km/s) and power/thickness of approximately 33 km (Aki, 1960; Kovach, Press, 1961). In the east part of Indian Ocean, is observed the "normal" cut/section of crust and mantle. Layer with the lowered/reduced speed assumes "soft"

mantle. The analysis of these given together with data heat fluxes allowed B. Heezen (Heezen, 1960) to trace the continuation of the Eastern Pacific Ocean elevation to California.

Measurements of heat flux.

Research on **heat flux is** based on the determination of temperature gradient ($\frac{\partial T}{\partial z}$) **at** measuring point. Knowing the temperature conductivity **(thermal** conductivity) of precipitation, is determined the value of heat flux according to the **formula:**

$$Q = \kappa \frac{\partial T}{\partial z}.$$

All the measurements, as a rule, are conducted near the surface of the bottom, in sedimentary layer, where is omitted on cable cylinder with sensing element.

To 1966 in seas and oceans, were made about 1000 measurements of heat flux (Herzen, Langseth, 1965). To the lct of the Southern Hemisphere, feels almost the half of all measurements. In the studied by us region (to the

south from 30° south latitude,) are counted about 100 points where is known the value of heat flux (Fig. 3). In near-Antarctic water (to the south from 60° south latitude) of such measurements a total of four. This is region between New Zealand and Ross Sea.

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There is report/communication, that measurements of heat flux they were carried out at some stations in the Antarctic part of the Pacific Ocean in band 60-68° south latitude on the American vessel "Eltanin" (Heirtzler, 1967). However, the results of these works, until now, are not published. As concerns the continent of antarctica, to the season of south-polar summer/years 1967/68. New-Zealand antarctic expedition was included in the plan for its work of investigation in heat flux.

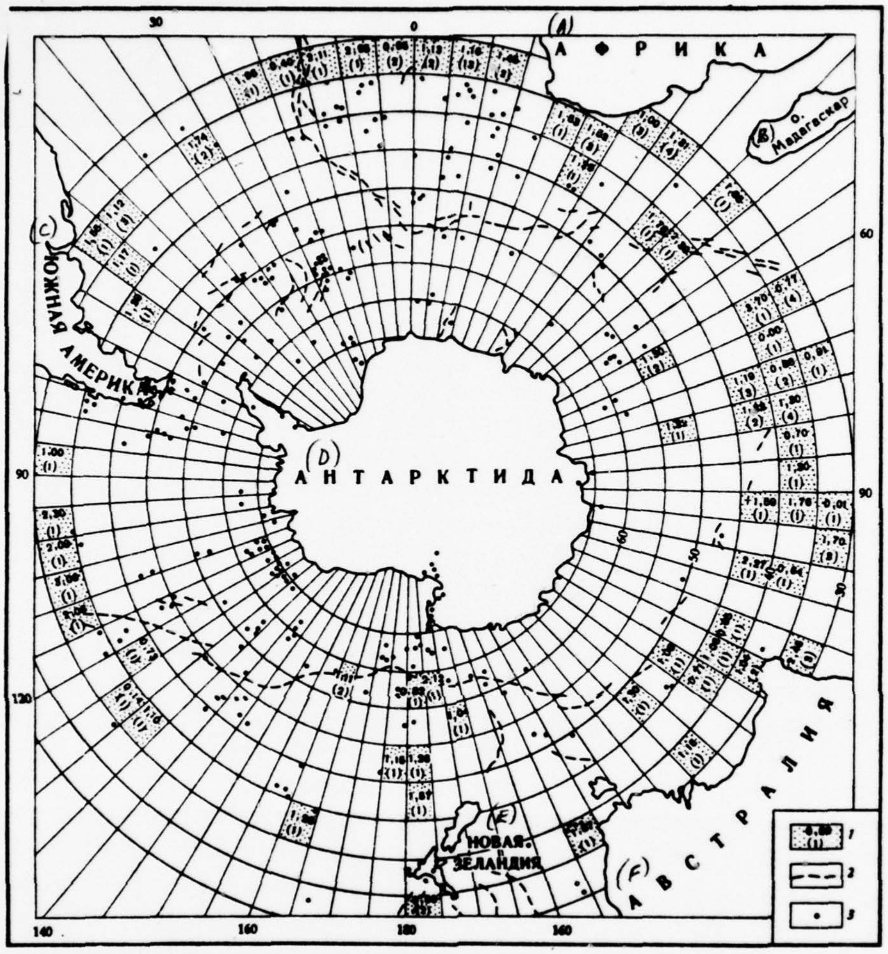

Fig. 3. Heat-flow distribution in south ocean (Herzen, Langseth, 1965). 1 - the average value of heat flux, μ cal/cm²•s in squares 5 x 5° (in brackets is shown the number of measurements); 2 - axis of oceanic spine/ridges; 3 - volcanos the acting extinguished.

Key: (A). Africa. (B). Is. Madagascar. (C). South America. (D). Antarctica. (E). New Zealand. (F). Australia.

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Was provided for to conduct the measurement of heat flux through the bottom of McMurdo Sound and Bonnie and Wanda Lakes, and also some measurements in region of Rennick Glacier. However, the results of these works on, until now, are unknown. All the measurements of heat flux in oceans are made in essence by American geophysicists from the Scripps Oceanographic Institute and the Lamont geologic observatory of Columbian university (Herzen, 1964).

Heat flux on the water area of south ocean changes within extremely large limits from the values, close to zero (0.01 $\mu cal/cm^2 \cdot s$), to 3.06 $\mu cal/cm^2 \cdot s$. For lack of data now it is difficult to make any conclusions about communication/connection of heat fluxes with one or the other structural cell/elements of the earth's crust. However, subsequently data on heat fluxes will aid us to reveal and is more full to explain some special feature/peculiarities of the physical fields of the Earth in the Southern Hemisphere.

Magnetic investigations.

Magnetic observations in the antarctic, and also during the water area of south ocean especially widely began to be conducted during the IGY. On the shore of Pravda Bereg in region of observatory Mirnyy in 1956-1957 1st SAE were made aeromagnetic observations (Glebovskiy, 1960). In 1960-1961 these works they were continued 5th SAE. During October 1960, were realized the flights along the routes: 1) Mirnyy - Is. Pobedy - point 59.3° south latitude, 103.0° east longitude - Mill Is. - Drygalski Is. - Mirnyy; 2) Mirnyy - Drygalski Is. - point 58.9° south latitude, 86.3° east longitude - Cape Penguin.

The total length of these profiles comprises approximately 4000 linear kilometers (Fig. 4). Aerial magnetometer ASMG-25, intended for continuous and automatic measurement ΔT_a in flight, was tugged by aircraft of IL-14. Flight altitude was 300-400 m (Lastochkin, 1967).

In flight along route Mirnyy-Lazarev in this same expedition was made the aeromagnetic profile Mawson-Seva-Lazarev by extent 2260 km. Measurements were carried out in essence above coastal waters of antarctic seas at heights from 100 to 300 m. When conducting of aeromagnetic photographing at Queen Maud Land (Lastochkin, 1967) in 1960-1961 it was made two maritime profiles by extent of approximately 1500 km enroute: Lazarev is a point 64.1° south latitude, 13.5° east longitude - a point 66.9° south latitude, 15.3° east longitude - Lazarev. In all way of flight, are obtained the values of anomalous magnetic field.

In water of south ocean, magnetic survey was conducted also by expeditions aboard ships.

The second Japanese antarctic expedition into 1957-1958 conducted the measurement of the components of magnetic field in Luetzow-Holm Bay and on two routes: Capetown-Seva and Capetown-Singapore (Oguti, Kakinuma, 1959).

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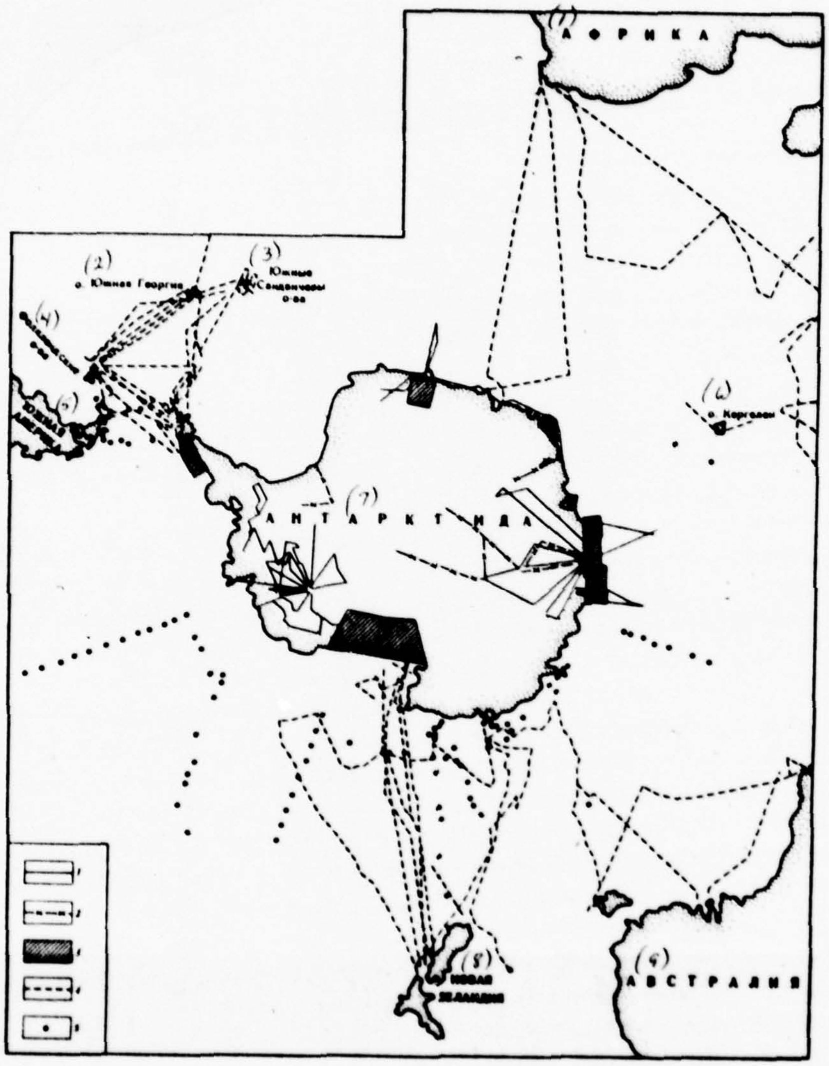
(1)
АФРИКА
(2)
о. Южная Георгия
(3)
Южные Сандвичевы о-ва
(4)
(5)
(6)
о. Кергелен
(7)
АНТАРКТИДА
(8)
НОВАЯ ЗЕЛАНДИЯ
(9)
АВСТРАЛИЯ
1
2
3
4
5

Fig. 4.

Fig. 4. Circuit of the magnetic study of south ocean and the limb zone of antarctica. Compiled by P. A. Stroyev. 1 - route of aeromagnetic photographing; 2 - route of ground-based magnetic survey; 3 - sections of area works; 4 - routes of hydromagnetic works; 5 - points of point measurements.

Key: (1). Africa. (2). South Georgia Island. (3). South Sandwich Is. (4). Falkland Is. (5). South America. (6). Isle de Kerguelin. (7). Antarctica. (8). New Zealand. (9). Australia.

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The measurements of magnetic field were fulfilled with the aid of the tugged maritime three-component proton magnetometer. The accuracy of measurement comprises $\pm 10\gamma$.

Hydromagnetic observations were conducted also in 2nd and 3rd SAE aboard the diesel-electric ship "Ob'" (Guzeyev, 1962). Cell/element measurements of magnetic field were conducted on some stations by the stationary established/installed on vessel sensors of ferroprobe

magnetometer. As a result were obtained the absolute values of comprising Z and H. In the diagram of magnetic study (see Fig. 4), these measurements are shown in the form of points.

Hydromagnetic observations in the Pacific Ocean sector of antarctica between Australia, New Zealand and antarctica are carried out by Japanese antarctic expedition into 1964-1965 on vessel "Umitaka-Maru" (Tomoda, 1966). The results of these measurements thus far are not published.

In sector boundary by New Zealand and Ross Sea the expedition on the vessel "Endeavor" fulfilled magnetic measurements into 1958-1959 and into 1963. General magnetic field strength was measured with the aid of the tugged nuclear magnetometer. The accuracy of measurements comprises $\pm(10-30)\gamma$.

The considerable volume of hydromagnetic investigations is made into 1961-1962 by English antarctic expedition (Griffiths et al, 1964). The measurement of the full/total/complete vector of magnetic field is made with proton magnetometer aboard the research ship "Shackleton". Region of works covers entire water basin of Scotia Sea, Drake Strait and island arc.

Magnetic measurements are carried out on the water area of Indian Ocean, including in its south part, by the coworkers of the Scripps institute of oceanography in expeditions "Monsoon" and "Luziad" into 1960-1963. Observations are carried out along the system of profiles to research ship "Argo" with the aid of the proton precision magnetometer. Unfortunately, the results of this photographing, until now, are not published.

Generally it must be noted that the results of maritime magnetic measurements are not largely published. In the majority of cases, are published only very common sketches or extremely small-scale profiles of the full/total/complete vector T (or H and Z), but not anomalies ΔT. All this, of course, impedes their quantitative interpretation and makes it possible to evaluate only qualitatively character and the special feature/peculiarities of magnetic field.

Aeromagnetic photographing on maritime routes at Davis Sea recorded alternating magnetic field with amplitudes 500-800γ (Lastochkin, 1967). The local character of anomalous

fields testifies to the shallow occurrence of the perturbation objects. The depths of sea do not exceed here 600-700 m, therefore, magnetic anomalies in all probability are connected with the underwater projections of strongly magnetic rocks of crystal basement. At large removal/distance from shore, where the depths of sea reach 3000-3500 m, the alternating/variable character of field, apparently, has communication/connection with the issuing from underwater lavas.

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The greatest brokenness of magnetic field (it is more than 2000γ) is observed along coast of east antarctica between stations Mirnyy and Lazarev. This is partly explained by the low height of photographing and by the small depth of sea at the shore. The cut character of field with considerable amplitudes testifies to approach/approximation to the topographic surface of the rock/species of Archean metamorphic complex. Alternating magnetic field with amplitudes from 200 to 1000 γ is recorded on maritime routes to north from station Lazarev.

Hydromagnetic photographing at Scotia Sea revealed the

high abnormality of South Georgia Islands, South Sandwich Islands, South Orkney. In Drake Strait, typical magnetic anomalies have a direction east- west, i.e., they coincide with the directions of basic geologic structures. Data of magnetic survey indicate the block structure of the upper part of the earth's crust.

The profiles, which intersect south ocean from shores of antarctica to the continents of Africa, to Australia and between the latter show the following character of magnetic field. The ocean basins with depths 4000-5000 m are characterized by alternating magnetic field with anomalies $\pm(200-300)\gamma$. Above mid-oceanic ridges anomalous magnetic field has sharply alternating/variable character, the values of anomalies in rift zones they reach $\pm 1000\gamma$.

The zones of junction from ocean to continents are characterized also by sharply alternating magnetic field with the amplitude of anomalies $\pm(500-1000)\gamma$. This is explained by approach/approximation to the topographic surface of magnetically active bodies.

It should be noted that the report of geophysical investigations enumerated above by no means does completely

encompass all works, which were being conducted in south ocean and the limb zone of antarctica. On many works are given very short report/communications. So, we almost nothing know about the results of investigations, which were being conducted by American maritime antarctic expeditions. From July 1962 through May 1966, the research vessel "Eltanin" completed 23 floatings in the Pacific Ocean sector of the antarctic. The main regions of investigations were Scotia Sea, Drake Strait and water of the south ocean between New Zealand and Chile. Aboard of vessel, were conducted seismic, magnetometric, gravimetric and geologic investigations, the measurements of heat flux, the photographing of the sea bottom and many other investigations (Sandved, 1966). Unfortunately, the results of these works are not published.

As concerns geophysical investigations in the limb zone of antarctica, then their results have presented in sufficient detail we in the work "earth's crust of the limb zone of antarctica" (systems, etc., 1967). As concerns later works, about them it is described in A. P. Kapitsy's work "under-ice relief of antarctica" (1968).

Data presented above on the study of south ocean and the limb zone of antarctica show that this study still is extremely insufficient.

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A very small quantity of seismic cut/sections to Mohorovicic's boundary in south ocean and an absence of the same on the sixth continent do not make it possible to make any concrete conclusions about the structure of the earth's crust and upper mantle of this region of terrestial globe. Therefore judgment about power/thickness and structure of the earth's crust of antarctica is necessary to make only on the basis of indirect methods. Is related the gravimetric method. The anomalies of the force of gravity will contain sufficient information in order to draw common/general/total conclusions about power/thickness and some lines of the structure of the earth's crust and upper mantle, to obtain the representation of depth and character of the basic bed of glaciers and to evaluate the isostatic state of region being investigated.

On the strength of the special feature/peculiarities of the structure of the sixth continent (glaciation), and also the special feature/peculiarities of method itself (mobility, transportability, cheapness, etc.) the gravimetric method has

especially important value during the study of the antarctic.

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Chapter II.

GRAVIMETRIC INVESTIGATIONS IN THE SOUTH OCEAN AND THE ANTARCTIC

Maritime gravimetric works of the moscow state university in the south ocean and the Antarctic.

Long time the production of gravimetric observations at sea was considered impossible as a result of the considerable effect of slope/inclinations and acceleration, created during the motion of ship under the action/effect of agitation. These effects reach 100000 mgal (acceleration during which are possible the maritime gravimetric measurements), while most measured value Δg composes several mgal or dozen mgal. Moreover value Δg must be measured with accuracy on the order of ± 1 mgal.

Only in the beginning of the 20's of our century F. Vening-Meinesz developed the pendulum method of the observation of the force of gravity at sea. He found the methods exception/elimination and account of the effect of the different perturbation acceleration and created the special type of pendulum instrument for maritime observations. During 1923-1930 Vening-Meinesz was conducted several underwater gravimetric expeditions on the water areas of Atlantic and Indian Oceans, in inland and redder seas and in water of seas, washing the island of Indonesia.

After the publication of Vening-Meinesz's method, the professor of the astronomical institute of Moscow University L. V. Sorokin immediately (into 1928) began to develop maritime gravimetric works in the USSR. He designed pendulum gravimeter for observations aboard ship. The first experiment floating on the submarine took place into 1930 in black sea.

The subsequent floatings were conducted by L. V. Sorokin in black sea in 1933, 1934 and 1935. In all in black sea were determined more than 120 gravimetric points.

Then L. V. Sorokin completed the task regarding gravitational force on the water areas of the Sea of Japan and Sea of Okhotsk. Photographing was carried out in summer of 1937. In this expedition were determined 170 gravimetric points.

Voyages of L. V. Sorokin were the first step/pitches in the investigation of the force of gravity at sea when was tested equipment and were studied conditions and very possibility of such observations. However, narrower these first measurements were carried out sufficiently accurately. The comparison of the prewar measurements of L. V. Sorokin with contemporary data showed that photographing, which was being conducted by L. V. Sorokin, does not have systematic errors and is characterized by random rms error of ±10 mgal (Stroyev, 1969; Stroyev, Markov, 1969).

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Thus, we now can with confidence say that the USSR'S first measurements of the force of gravity at sea which were estimated as very rough and completely were disregarded, in its accuracy were close to contemporary determinations and are completely suitable for their utilization in practical target/purposes.

After the first works of F. Vening-Meinesz and L. V. Sorokin into 1937 K. Brown expressed critical observations apropos of the theory of maritime pendulum measurements. It showed that the perturbation acceleration of the square significantly affects pendulum measurements. It was necessary to develop theory, to find the methods recording and account of these acceleration. In the USSR Brown's theory was perceived so seriously that All-Union gravimetric conference 1940 was recommended to restrain from the measurements of the force of gravity at sea to the creation of equipment for the measurement of slopes and acceleration, acting on pendulum gravimeter under maritime conditions.

World War II 1941-1945 stopped these works. After war Professor Sorokin continued investigations in the region of maritime gravimetry. In 1947 he headed expedition in the Barents Sea.

In 1936 L. V. Sorokin together with V. V. Fedynskiy conducted the USSR'S first experiment in the observations on pendulum gravimeter aboard surface ship. After war these

experimental works were continued. Once into 1953-1954, in expedition of MGU [Moscow State University] on research ship "Vityaz'" to pendulum gravimeter was adapted long-period pendulum for recording of horizontal acceleration. However, as a whole work in the region of maritime pendulum observations was developed weakly. It bore accidental character, since there was an opinion about the insufficient urgency of maritime gravimetric measurements.

To 1955 position sharply it changed. On the eve of international geophysical year into GAISh was organized the constantly acting maritime gravimetric expedition (Grushinskiy, 1967). The scientific leaders of this expedition are V. V. Fedynskiy and N. P. Grushinskiy. Basic problem of the gravimetric expedition of GAISh - research on the gravitational field of world ocean and antarctic.

The first gravimetric expedition into the antarctic was organized into 1954 on the initiative of V. V. Fedynskiy. Were conducted incidental measurements aboard the factory ship "Slava" and on tanker "Apsheron". Expedition had mainly systematic problems. Actually this was Soviet gravimetric analysts's quite first outcrop into world ocean.

Observations were conducted by two pendulum gravimeters. Recordings of the perturbation acceleration were not conducted, but the effect of the latter was estimated according to the fluctuations of the marks per second on the recording of swings of the pendulum. Therefore photographing on "Slava" has, with perturbation acceleration, systematic errors on the order of +20 mgal and random errors ±16 mgal. Nevertheless the expedition, which carried out of 75 gravimetric points in Atlantic Ocean and especially in its south part, had large value.

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Gravimetric measurements would allow at least in the first lines to present the character of the gravitational field of this insufficiently studied water area. Besides the significance of the most obtained material, the expedition acquired work experience in antarctic waters and determined the main direction of the improvement of equipment and measurement procedure.

In 1955 to the Antarctic went the first Soviet antarctic expedition. Aboard the diesel-electric ship "Ob'" was located gravimetric branch of the GAISh which made the

measurements of gravitational force according to the plan for the expedition of this vessel. In this expedition for the first time in the practice of Soviet maritime gravimetric works were applied the accelerometers for recording of the perturbation acceleration (unit RNVU), and was also used crystal oscillator for timing on the recording of swings of 9the pendulum. In 1st SAE were for the first time obtained data on the gravitational field of the coastal zone of the Indian sector of the antarctic.

Gravimetric analysts of GAISh in 2nd SAE in 1956-1957 on diesel-electric ships "Ob'" and "Lena" continued the measurements of the gravitational force of coast of antarctica and in water of south ocean. Works were carried out at coasts on Queen Maud Land, the Davis Sea, where it is determined about 80 gravimetric points.

Maritime gravimetric measurements in 2nd SAE to a considerable degree differed from preceding/previous. For this expedition specially is prepared maritime pendulum gravimeter. Instrument was supplied by slow pendulums and vertical accelerometer. Here were for the first time applied the quartz pendulums, designed and prepared in TsNIIGAiK [Central Scientific Institute of Geodesy, Aerial Surveying and

Cartography]. Were here applied for the first time the special quartz clocks, constructed into GAISh. The application/use of these hours made it possible to completely exclude error for clock rate. On the basis of theoretical prerequisite/premises and experiment in the preceding/previous expeditions, was applied the new procedure of observations. Its basic cell/elements consisted in the sharp limitation of conditions, with which were conducted the observations. In this expedition for the first time in the practice of above-water observations was applied the maritime strongly-damped gravimeter of VNIIGeofizika. To these was placed the beginning of the combined utilization of maritime gravimeters and pendulum gravimeters.

In 3rd SAE in 1957-1958, maritime gravimeter branch of GAISh carried out the considerable volume of work in the east part of the Indian sector and in the Pacific Ocean sector of south ocean. In this expedition maritime gravimeter was utilized narrower as service instrument. Pendulum points served as supporting/reference. This expedition introduced the classification of maritime points according to work conditions, after dividing points in the ice and maritime, obtained during different sea ratings. Further points they began to estimate on categories.

All the subsequent expeditions improved the quality of the work with the way of the improvement of apparatus and procedure.

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This involved reduction in the total number of measured points, then it sharply improved their quality. The accuracy of the determinations of the gravitational force increased almost double.

In 1959-1960 in the composition 5th SAE on diesel-electric ship "Ob'" gravimetric branch of GAISh carried out the measurements of the gravitational force in the Atlantic and Pacific Ocean sectors of the antarctic. The determinations of the gravitational force are carried out by pendulum gravimeters and damped gravimeters in 131 points.

In 1960-1961 gravimetric analysts of GAISh in the composition 6th SAE were conducted the measurements of the gravitational force of shelf glaciers and in the

circumlittoral part of the Indian sector of antarctic continent. Voyage in ice conditioned small values and a good recording of the perturbation acceleration. Expedition showed that in antarctic water on surface vessel in the absence or the low value of the perturbation acceleration can be reached the high accuracy of gravimetric measurements (±4 mgal). The work 6th SAE considerably perfected the procedure of processing the results of pendulum determinations (introduction of corrections for amplitude, for acceleration).

In 7th SAE gravimetric branch of GAISh carried out the measurements of the gravitational force in 52 maritime points in the Indian sector of the antarctic. This expedition created strong point on Enderby Land (Molodezhnaya Sta.). The materials of combined pendulum and gravimetric observations made it possible to develop the procedure of the treatment of the observations of damped gravimeters. Was applied the procedure of value determination of the creeping of null point and standardizing of gravimeters from the pendulum observations, combined with gravimetric ones.

8th Soviet antarctic expedition on diesel-electric ship "Ob'" in 1962-1963 concentrated its work in regions of

Soviet stations Lazarev, Molodezhnaya, Mirnyy. Was here carried out several dozens of maritime gravimetric points. However, the more important result of these work was the measurement of the gravitational force in latitudes "howling 40°s" and "raging 50°s" on the way from Capetown to Mirnyy (Fig. 5). These are and thus far only this region's first gravimetric measurements.

In 8th SAE for the first time in the antarctic were carried out the tests of string gravimeter, which showed that this instrument is completely suitable for the measurement of the gravitational force with floating in south ocean and water of the antarctic. Advantage and the great advantage of string gravimeter is the absence of the creeping of the null point of the system of gravimeter.

The gravimetric branch of GAISh, which took part in 9th voyage of diesel-electric ship "Ob'" into the antarctic, continued the measurements of the gravitational force in the Indian sector of the antarctic. Expedition solved the number of questions of the improvement of the procedure of maritime gravimetric measurements. This of the problem of standardizing and determining the time constant of gravimeters.

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Damped gravimeters of the type S3-VNIIGeofizika must be standardized in the working range, since their scale divisions may be nonlinear. Gravimeters intended for measurement of the force of gravity in the Antarctic must be standardized at a point with latitude of 60-65°.

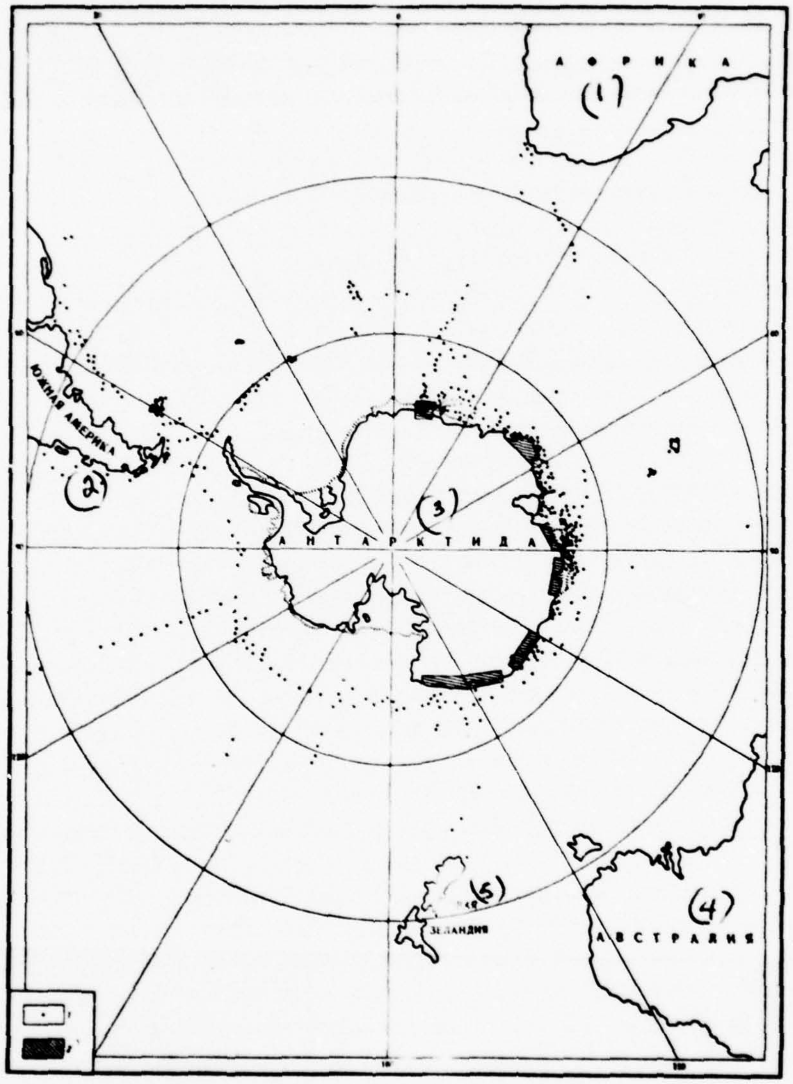

Fig. 5. Set-up of gravimetric experiments of GAISh in south ocean and antarctic. Compiled by P. A. Stroyev. 1 - observation stations; 2 - area photographings.

Key: (1). Africa. (2). South America. (3). Antarctica. (4). Australia. (5). New Zealand.

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Therefore the 9th SAE was the first to experiment with standardizing of instruments in region of operations, on Antarctic shore. Investigations are carried out in observatory peaceful on supporting/reference gravimetric point - in space pavilion. The scale value of instruments was determined by the method of slope/inclination on plate/platform. Were there determined time constants of gravimeters.

The last/latter work of the gravimetric analysts of GAISh in the antarctic were carried out in the period of floating on scientific research vessel "professor Zubov" during December 1968; March 1969 gravimetric investigations were conducted in the Indian and Atlantic sectors of the south ocean and antarctics. The measurements of the gravitational force were carried out with the aid of pendulum gravimeter, damped gravimeter, and also the maritime automated gravimeter ANG-M of the construction of GAISh

(Panteleyev, etc. 1967). This is Soviet gravimetric analysts's first experiment in the utilization of a maritime gravimeter on the continuous recording of the gravitational force in motion of vessel in the antarctic. In this expedition was carried out several thousands of kilometers of profiles with the measurement of the force of gravity.

Circumlittoral and land gravimetric work of GAISh in a limb zone of antarctica.

By the first work of GAISh on neve and land ice, and also on the very continent of Antarctica one should consider the pendulum and gravimetric definitions, carried out by maritime branch on diesel-electric ship "Lena" into 1956-1957 (Zommer, Gaynanov, 1961). For this expedition it was possible to carry out four pendulum points: one point - at station Mirnyy, two points - in Sandefjord Bay, one point - in Edward VIII Bay.

Pendulum observations are carried out on four-pendulum holder of the construction of GAISh with two assemblies of bronze pendulums, two integral resistance thermometers and

two contact chronometers. The most important value has the determination of the gravitational force at Mirnyy Sta. - the center of Soviet antarctic expeditions. This point became the strong point of all Soviet gravimetric determinations in antarctica.

Besides pendulum points, by the order it is determined 20 gravimetric (GAK-3M) points. Points are arrange/located on the Amery Ice Shelf (8 points), in Edward VIII Bay (6 points), and also on the Kemp Coast (6 points). It should be noted that this were the first Soviet land determinations in antarctica.

In 1957-1958 gravimetric branch of GAISh carried out on continent and glaciers of 110 points. Coastal photographing was carried out on three sections. On the first section by the extent more than 1000 km (from Leopold and Astrid Coast to Knox Coast) was carried out 70 gravimetric points, on the second section (Sabrina Coast and Banzare Coast) - 15 points, on the third (George V Coast and Oates Coast) - 25 points.

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Measurements were conducted by gravimeters GAK-3M with the root-mean-square error of anomalies ± 3 mgal.

This same by expedition were carried out two land Pendulum points: at Mirnyy Sta., another - on George V Coast. At Mirnyy are carried out the observations according to the program of points I and of II classes.

The GAISh branch of the 5th SAE into 1959-1960 continued the land determinations of the gravitational force in antarctic coast. Pendulum observations were carried out at Mirnyy Sta. and in the Wohlthat Mts. in Queen Maud Land, gravimetric observations with the GAK-3M - at the Showa and Mawson Stations, in Wohlthat Mts., and also on shelf glacier of station Lazarev. Observations on Lazarev Glacier (29 points) were carried out on the request of the management/manual of expedition for determining the depths of under-ice relief. The results of measurements and calculations of the depths of the basic bed of glacier showed that under station Lazarev is located deep depression of the sea bottom (Fig. 6). The depth of sea here is 700 m and more. The edge of the glacier on which is arrange/located Soviet south-polar wintering, is located to "float" and can be detached away from the

common/general/total mass of glacier.

In 1960 station Lazarev was enclosed, instead of it organized new wintering is a station Novolazarevskaya, arranged/located on the bedrocks of Shirmacher Oasis 80 km of shore of sea.

The gravimetric branch of GAISh of 7th SAE into 1961-1962 together with the coworker of geologic order S. A. Ushakov conducted land gravimetric measurements in the western part of Enderby Land. For conducting photographing, is carried out the determination of strong point on continent. For this, aboard diesel-electric ship "Ob'" in parking area was carried out the observation of pendulum point according to the program of maritime strong point. Then with the aid of gravimeter GAK-3M three voyages on aircraft produced the transmission of the gravitational force in shore - to moraine (basis of the geologic order). From this point is carried out gravimetric photographing on aircraft in region of the work of geologic order. In all it was made 26 points, including supporting/reference range/polygon from 6 points at station Molodezhnaya, on which leans entire/all photographing in region of Enderby Land.

Land work on Enderby Land were continued by the branch of GAISh in 8th SAE into 1962-1963. Observations are carried out with gravimeters GAK-3M in 47 points in region of Scott, Tula, and Napier Mts., Simmers Peaks, and in interior of Enderby Land. The root-mean-square error of anomalies is ±3.5 mgal. This same by expedition station Molodezhnaya was connected with reference point - station Mirnyy.

Besides gravimetric observations on the very continent of antarctica, expedition of GAISh carried out the observations in the numerous ports of Europe, Africa, Asia, America, Australia, and alsc on the islands of Atlantic, Indian, Pacific and south Oceans.

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Common/general/total results of gravimetric expeditions of GAISh in a south ocean and an antarctic.

During period from 1954 on 1969, the State Astronomical Institute im. P. K. Sternberg was carried out 11 expeditions into the antarctic and the south ocean.

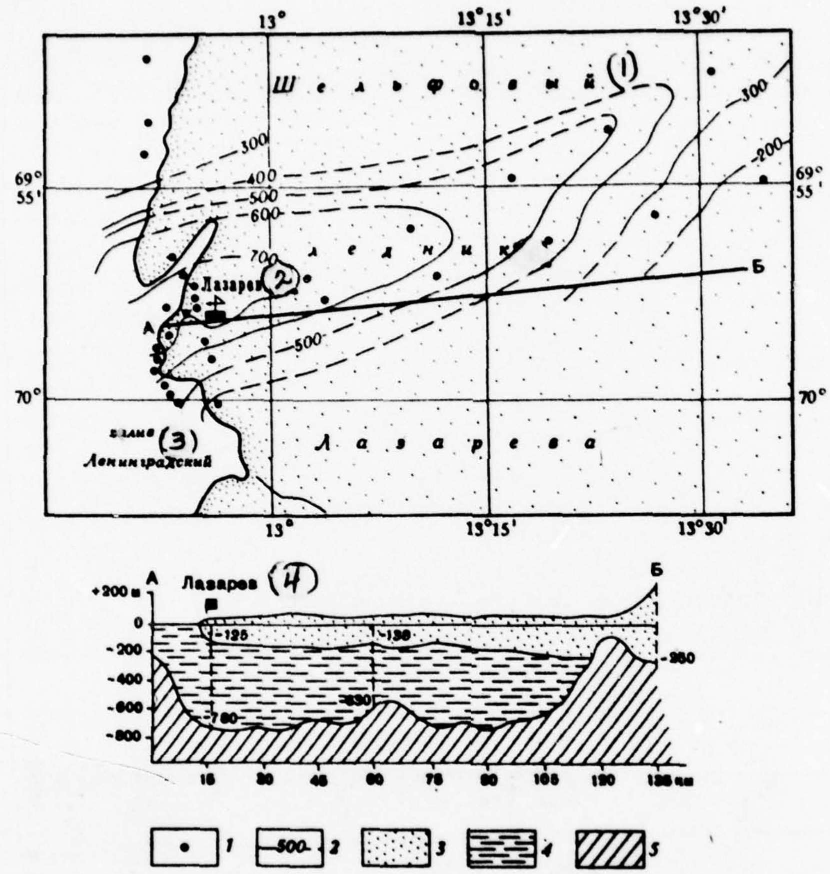

Fig. 6. Circuit of under-ice relief in region of station Lazarev according to gravimetric data (according to A. I. Frolov, 1963).

Key: (1). Lazarev Ice Shelf. (2). Lazarev. (3). Leningrad Bay. (4) Lazarev.

Pages 30 and 31.

Table 1. Report of gravimetric measurements of GAISh in the antarctic.

Экспедиция (1)	Годы рейса (2)	Судно (3)	Участники экспедиции (4)	На море (5)				На материке (6)			
				Маятниковые пункты (7)	Ср.кв. ошибка, мгл (8)	Гравиметровые пункты (9)	Ср.кв. ошибка, мгл (8)	Маятниковые пункты (7)	Ср.кв. ошибка, мгл (8)	Гравиметровые пункты (9)	Ср.кв. ошибка, мгл (8)
Китобойная (10) экспедиция	1954–1955	"Апшерон" (11), "Слава" (13)	А.Г.Гайнанов, (12) Е.Д.Корякин (14)	75	±16[x1]	–	–	–	–	–	–
1-я (st) САЭ	1955–1956	"Обь" (15)	А.Г.Гайнанов, (12) Е.Д.Корякин, (14) С.А.Ушаков (16)	39	±9	–	–	–	–	–	–
2-я (nd) САЭ	1956–1957	"Обь" (15)	Н.П.Грушинский, (17) В.А.Гладун (18) П.А.Строев (19) И.А.Епишин (20)	31	±10	62	±10	–	–	–	–
2-я (nd) САЭ	1956–1957	"Лена" (21)	И.Э.Зоммер, (22) В.Н.Коржев, (23) И.Н.Гончаров (24)	–	–	17	±13	4	±2	20	±3,2
3-я (rd) САЭ	1957–1958	"Обь" (15)	А.И.Фролов, (25) В.Н.Коржев, (23) Е.Д.Корякин, (14) С.А.Ушаков (16)	95	±10	–	–	2	±2	95	±3,7
5-я (th) САЭ	1959–1960	"Обь" (15)	А.И.Фролов, (25) Е.Д.Корякин (14)	19	±8,3	78	±9,0	2	±2	32	±3

Table 1. Continued

6-я th САЭ	1960-1961	"Обь" (15)	П.А.Строев, (19) Б.И.Козлов, (26) В.С.Симаков (27)	61	±3,5[xxx][2]	44	±3,5	-	-	2	±1,5
7-я th САЭ	1961-1962	"Обь" (15)	В.А.Гладун, (18) Ю.В.Бобров (28)	19	±4,5	33	±6,0	-	-	26	±3
8-я th САЭ	1962-1963	"Обь" (15)	Е.Д.Корякин, (14) А.В.Стакло (29)	18	±4,3	61	±9,0	-	-	51	±3,5
9-я th САЭ	1963-1964	"Обь" (15)	И.Н.Капцова, (30) А.С.Кузьмин, (31) Ю.П.Измайлов (32)	10	±2,8[xxx][3]	74	±8,5	-	-	3	±2
14-я th САЭ	1968-1969	"Проф. Зубов" (33)	Е.Д.Корякин, (14) А.И.Фролов, (25) Ю.В.Бобров (28)	16	±(3-7)	6000 миль (34) непрерывной записи по 9 профилям	±(3-15)[xxxx][4]	-	-	1	±3

Key: (1). Expedition. (2). Years of voyage. (3). Vessel. (4). Participants of expedition. (5). At sea. (6). On continent. (7). Pendulum points. (8). RMS, mgal. (9). Gravimetric points. (10). Whaling expedition. (11). "Apsheron" (12). A. G. Gaynanov. (13). "Slava" (14). Ye. D. Koryakin. (15). "Ob'" (16). S. A. Ushakov. (17). N. P. Grushinskiy. (18). V. A. Gladun. (19). P. A. Stroyev. (20). I. A. Yepishin. (21). "Lena" (22). I. Ye. Zommer. (23). V. N. Korzhev. (24). I. N. Goncharov. (25). A. I. Frolov. (26). B. I. Kozlov. (27). V. S. Simakov. (28). Yu. V. Bobrov. (29). A. V. Staklo. (30). I. N. Kaptsova. (31). A. S. Kuz'min. (32). Yu. P. Izmailov. (33). "Prof. Zubov" (34). the miles of continuous recording according to 9 profiles.

FOOTNOTE [1]. Perturbation accelerations were not considered.

[2]. Photographing is carried out with low value of perturbation accelerations.

[3]. All pendulum points - mooring.

[4]. Estimation of points is carried out differentiated depending on value of perturbation acceleration (Ye. D. Koryakin, maritime gravimetric measurements in 14th SAE, Info. Bull. SAE, 1970, No. 79). ENDFOOTNOTE.

Pages 32 and 33.

Table 2. Report of the measurements of the gravitational force by the gravimeters of VNIIGeofizika.

Экспедиция (1)	Годы (2)	Исполнитель работ (3)	Прибор (4)	Методика съемки (5)	Средняя квадратическая ошибка, мгл (6)	Способ оценки точности гравиметра (7)	Количество пунктов, определенных гравиметром (8)
2-я САЭ	1956-1957	Н.П.Грушинский (9) П.А.Строев (12)	СЗ-1	Интерполяционная съемка между маятниковыми пунктами (10)	±10,5	Сопоставление с маятниковыми наблюдениями (11)	81
2-я САЭ	1956-1957	И.Э.Зоммер (13)	СЗ-1	То же (14)	±13,0	Сопоставление с береговыми пунктами (15)	17
3-я САЭ	1957-1958	А.И.Фролов (16)	СЗ-4	Наблюдения на маятниковых пунктах (17)	±(5,0-8,5)	Сопоставление с маятниковыми наблюдениями (11)	95
5-я САЭ	1959-1960	А.И.Фролов (17)	СЗ-1	Наблюдения с маятниковыми приборами (18)	±(3,8-9,1)	То же (14)	89
6-я САЭ	1960-1961	П.А.Строев (19)	СЗ-10	То же (14)	±(3,8-4,7)	Сходимость между гравиметровыми и маятниковыми наблюдениями (20)	105
7-я САЭ	1961-1962	В.А.Гладун (21)	СЗ-10,СЗ-8	•	±(4,2-6,0)	То же, плюс сходимость между гравиметрами (22)	52
8-я САЭ	1962-1963	Е.Д.Корякин (23)	СЗ-10,СЗ-8	Профили в Индийском и Атлантическом океанах, опирающиеся на опорные точки (24)	±9,0	Сравнение с картой аномалий в свободном воздухе (25)	76
9-я САЭ	1963-1964	И.Н.Капцова (26)	СЗ-10,СЗ-8	Наблюдения с маятниковым прибором (27)	±(5,9-8,7)	Сравнение с картой аномалий (28)	84
14-я САЭ	1968-1969	Е.Д.Корякин (23)	СГК-5	То же (14)	±(3-10)	Сопоставление с маятниковыми наблюдениями (11)	34

Key: (1). Expedition. (2). Years. (3). Executor of work. (4). Instrument. (5). Procedure of photographing. (6). The root-mean-square error, mgal. (7). Method of estimating the accuracy of gravimeter. (8). Quantity of points, determined by gravimeter. (9). N. P. Grushinskiy. (10). Interpolation photographing between pendulum points. (11). Comparison with pendulum observations. (12). P. A. Stroyev. (13). I. Ye. Zommer. (14). The same. (15). Comparison with coastal points. (16). A. I. Frolov. (18). Observations with pendulum gravimeters. (19). P. A. Stroyev. (20). Convergence between gravimeter and pendulum observations. (21). V. A. Gladun. (22). The same, plus is convergence between gravimeters. (23). E. D. Koryakin. (24). Profiles in Indian and Atlantic Oceans, which lean on data points. (25). Comparison with the map/chart of anomalies in free air. (26). I. N. Kaptsova. (27). Observations with pendulum gravimeter. (28). Comparison with the map/chart of anomalies.

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In all in these expeditions is carried out more than 1500 gravimetric determinations with the accuracy of the anomalies of the gravitational force ±(5-10) mgal. Data of gravimetric measurements, produced by GAISh in antarctic expeditions, are given in Table 1.

As is evident, the maritime gravimetric investigations of GAISh (see Fig. 5) they make it possible in the first approximation, to present the gravitational field of the south ocean and especially the antarctic. Gravimetric points gird antarctica by the almost closed ring and give the representation of earlier in no way the investigated in gravimetric sense region of the earth.

Gravimetric measurements in world ocean and the antarctic, initiated on the eve of IGY by GAISh are continued and at present. After this time is accumulated a large experiment in the gravimetric investigations. The expeditions of GAISh conducted measurements of gravitational force in the open ocean and outlying seas, in water and in ice of the antarctic, on the neve and shelf glaciers of antarctic coast, on continent itself to antarctica. Gravimetric work were conducted on the different types of vessels of different tonnage. The measurements of the gravitational force were carried out by pendulum gravimeters and the gravimeters of different types. There is considerable interest in the application/use of gravimeters for the measurement of the gravitational force aboard the

ship. The antarctic expeditions of GAISh it gave "pass in life" to the maritime damped gravimeters S3-VNIIGeofizika. This gravimeter was adopted as service instrument. Table 2 gives the report of the measurements of the gravitational force by the onboard gravimeters of VNIIGeofizika by the expeditions of GAISh in Soviet antarctic expeditions.

In all in nine antarctic expeditions with the aid of onboard gravimeters is carried out more than 600 gravimetric points whose accuracy corresponds to the accuracy of pendulum determinations. The application/use of gravimeters made it possible to substantially increase the productivity of gravimetric work on ships.

Gravimetric investigations in an antarctic of other Soviet expeditions.

First Soviet area gravimetric photographing in coast of antarctic continent is carried out into 1956 by geological-geophysical order 1st SAE. A. K. Dorosin determined 149 gravimetric points on islands, on fast ice in region of observatory Mirnyy and in region of Bunger

Oasis. Measurements are carried out with gravimeters GAK-3M and SN-3; the accuracy of the determination of anomalies ±2 mgal.

In 2nd SAE into 1956-1958 in expedition enroute Mirnyy-Komsomol'-Vostok, G. Ye. Lazarev carried out the determinations of the gravitational force with the aid of gravimeters SN-3 more than in 100 points. The heights of points are determined by barometric leveling.

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The errors in separate points are possible to 100 m; the average error of heights, apparently, about ±30 m. Therefore the errors of the anomalies of the force of gravity exceed ±10 mgal.

In 3rd SAE into 1957-1959 along route Mirnyy-Komsomol'skaya-Vostok and Komsomol'skaya-Pole of Inaccessibility Yu. N. Avsyuk determined 88 gravimetric points. The heights of points are obtained according to data of aerobarometric leveling with mean error ±20 m. The root-mean-square error of the determination of the force of gravity is estimated in ±2 mgal.

In 4th SAE into 1958-1960 along route Mirnyy-Komsomol'skaya by S. N. Shcheglov were carried out gravimetric determinations in 72 points. Were utilized three gravimeters SN-3. Accuracy of the determination of the force of gravity of approximately ±2 mgal. For the first time in the antarctic in this expedition, was applied geodetic method for determining the heights of points. Results are estimated at error ±(2-3) m. In this same period into 1958-1959 in composition 4th SAE the order of the Institute of Physics of the Earth of the AS USSR (leader of order Yu. P. Izmailov) conducted maritime gravimetric determinations. In all in the antarctic is carried out more than 60 points, of them 44 points it is determined with the aid of maritime gravimeters GAL, 16 points determined with pendulum gravimeter. On 7 points are carried out combined pendulum and gravimetric observations.

On neve ice it is determined of 7 points with gravimeter SN-3. The accuracy of determination is characterized by following by the root-mean-square errors: pendulum mooring points ±2 mgal, ice ±3 mgal, maritime ±(5-7) mgal.

In 1960-1961 by orders 5th SAE were carried out the determinations of the gravitational force on West Ice Shelf (93 points), on Pobeda Is. (20 points), on route Mirnyy-Komsomol'skaya-Vostok (86 points). Observations are carried out by V. B. Tsukernik and American geophysicist H. Duart with GAK-3M and Worden gravimeters. The accuracy of the determination of the force of gravity taking into account all errors is evaluated at ±(1-2) mgal. For determining the heights, was applied the barometric leveling. This same by expedition on the Lazarev Ice Shelf and in coast in region of the Shirmacher Oasis it is carried out of 224 points (L. I. Bokanenko, P. Ye. Svetlayev) with the aid of gravimeters SN-3 and GAK-3M. The heights of points were determined by barometric leveling, error in determination heights ±(4-8) m. Entire/all photographing is characterized by the RMS error of the anomalies of the force of gravity ±(3-5) mgal.

The detailed gravimetric investigations of the western part of Shackleton Ice Shelf are carried out by 6th SAE into 1961-1962. The determinations of the gravitational force (G. Ye. Lazarev) were conducted by two gravimeters GAK-3M

and by two gravimeters SN-3. The heights of points are determined by barometric leveling, error their ±5 m. In all on the glacier it is carried out of 70 points with the error in determination of the force of gravity about ±(1.5-2.0) mgal.

In 1964 seasonal composition 9th SAE carried out expedition on route Vostok - Pole of Inaccessibility - Molodezhnaya.

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In the general complex of the geophysical works the expedition carried out gravimetric measurements at 169 points with a middle interval between points approximately 20 km. The coordinates of points were determined by astronomical method (35 points) and with calculation of covered path, the heights of points - by barometric leveling with a middle interval between points 10 km. The error in determination of the heights of points, in the opinion of S. N. Bugayev, is ±18 km.

Figures 7 gives the circuit of the gravimetric study of the continent of antarctica by Soviet (besides GAISh)

and foreign expeditions (intracontinental expeditions in the diagram are shown not all).

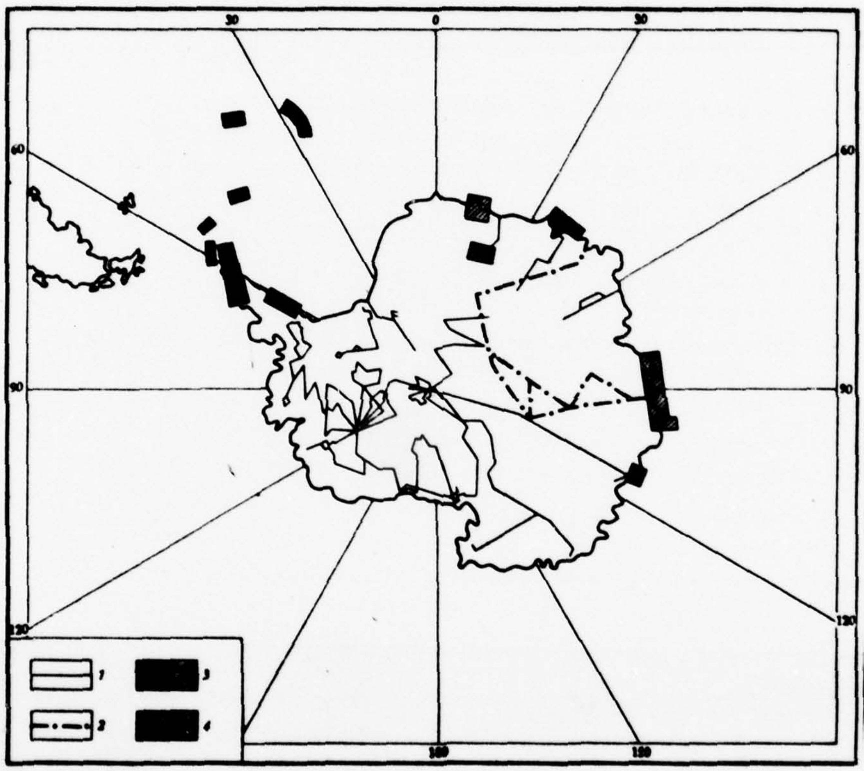

Fig. 7. Set-up of gravimetric experiments in antarctica (investigations of GAISh are not included). Compiled by P. A. StroYev. 1 - routes of foreign expeditions; 2 - routes of Soviet expeditions; 3 - area photographings of foreign expeditions; 4 - area photographings of Soviet expeditions.

Gravimetric investigations in a south ocean and an antarctic cf foreign expeditions.

The foreign countries also introduced the considerable contribution to research on the gravitational field of the antarctic. So, Western antarctica is completely invastigated by foreign expeditions. Only into 1968-1969 GAISh conducted gravimetric observations on Smith Is. (Borodino). In east antarctica by the expeditions of other states are carried cut in essence route investigations, in detail are studied only small sections.

To the first gravimetric foreign investigations in east antarctica, one should relate the route measurements of Australian expedition on Mac-Robertson Land. During 1957-1959 this expedition carried out two expeditions from Mawson Sta. to Prince Charles Mts. (73°S). The measurements of the force of gravity were carried out with the aid of the Warden gravimeter of geodetic type through every 8-10 km of expedition. The account of the creeping of null point was achieved on control measurements on the way back and on

strong point at Mawson Sta. In all on these two routes it is carried out of 133 gravimetric points. Furthermore, in summer 1958-1959 in the vicinities of Mawson Sta. was depleted the range/polygon where it is determined 42 gravimetric points. Unfortunately, data of these determinations are published only in the form of curve/graphs and circuits (Goodspeed, Jesson, 1959). On Wilkes Land Australian expedition into 1962 performed vast gravimetric investigations. In the vicinities of Wilkes Sta. is carried out area photographing (26 points). From Wilkes Sta. to the east to the Totten Ice Shelf is carried out a 335- mile expedition in which it is determined 84 gravimetric points. Finally, is carried out route from Wilkes Sta. to Vostok Sta. by the length of 1774 miles. On this route is determined of 464 gravimetric points with average distance among the points of the less 3 miles. The measurements of the gravitational force were determined by two Worden gravimeters, height - by barometric leveling (Walker, 1966).

By Japanese scientists is studied region of antarctic coast on the shore of prince Harold, of the station of sowing.

In 1957-1959 Japanese geophysicists performed gravimetric determinations at Showa Sta., on the Ongul Islands, and on many-year fast ice in Luetsow-Holm Bay (Harada et al., 1963). The measurements of the gravitational force are carried out in 23 points by the gravimeter of Worden with the accuracy of anomalies ±10 mgal. In 1961 was developed the route in Luetsow-Holm Bay from Showa Sta. towards the Riiser-Larsen Peninsula. It is here determined 17 points with error in measuring ±3.5 mgal. Into 1959-1961 Japanese scientists were conducted gravimetric determinations during sleigh-tractor expeditions from Showa Sta. to Yamato Mts., on Midzuho Plateau to 76° south latitude, to Shirase Glacier. In all is travelled more than 2500 km; by this method is determined about 150 gravimetric points (Oura, 1965).

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On Princess Ragnhild Coast Belgian expedition performed gravimetric survey in Soer Rondane Mts., and also on route Roi Baudoin Sta. - Soer Rondane Mts. All the observations in mountains are carried out on the bedrocks. Was utilized the Worden gravimeter. In all it is determined about 40 points with the error of anomalies ±(3-5) mgal (Autenboer, 1964).

All remaining work in east antarctica were conducted on some routes with different density of the arrangement of points. These are the routes of the expeditions: 1) France (1957-1959) from Dumont d'Urville Sta. at 140° east longitude to Charcot Sta. on Adelie Land; 2) the USA (1959-1960) from Dumont d'Urville Sta. at 139° east longitude to 71°5' south latitude and farther; one route to the east to the point with coordinates 72°5' south latitude and 160° east longitude, and the second - to the south-east, through the mountain mass to McMurdo Sta.; 3) the joint British-New-Zealand expedition, making gravimetric determinations on route from South Ice Sta. to Amundsen-Scott Sta. and further to Scott Sta. on Ross Ice Shelf; 4) USA (1964-1966) from Amundsen-Scott Sta.at the South Pole to the Pole of Inaccessibility Sta. and to Plateau Sta.; on this route carried out more than 2500 km.

In Western antarctica area gravimetric photographing is carried out on the Filchner Ice Shelf, in region of South Pole, to Ellsworth Land, in antarctic peninsula, in region of Byrd Sta. and on Ross Ice Shelf, in region of McMurdo. In the remaining territory of Western antarctica, are carried out the numerous routes of sleigh-tractor expeditions

and routes of aerogeophysical investigations in essence of American expeditions. In antarctic peninsula the considerable number of gravimetric observations carried out English expeditions, and also Argentinean and Chile.

On islands of the southern-Antilles arc, the considerable volume of gravimetric work is carried out by English antarctic expedition into 1959-1963. On South Shetland Islands and in the northern part of Graham Land is determined about 150 gravimetric points, on South Georgia Is. - 18, on South Sandwich Islands - 6, on South Orkney Islands - 12. All the measurements taken with the aid of two Worden gravimeters with the error of the anomalies of the force of gravity ±(3-5) mgal (Griffiths et al., 1964). There are several definitions, made by Australian expeditions to other islands of the south ocean: Mcquarie, Heard, Isles de Kerguelen, and also to the group of Antarctic islands in region of Wilkes and Davis Stas. (Langron, 1966). By Soviet expeditions are carried out measurements of the force of gravity near the Isles de Kerguelen, Balleny, Price Edward, Easter Islands, etc.

Foreign gravimetric determinations on the water area of the Southern Ocean began widely to be conducted only in

the latter of decades. So, American geophysicists on the vessel "Eltanin" during 1962-1965 completed more than 20 floatings with gravimetric measurements in the south part of Pacific Ocean, in zone 40-65° south latitude.

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Japanese expedition in 1964-1965 conducted maritime gravimetric measurements on the water area of ocean between Australia, New Zealand and antarctica. English scientists on vessel "Protector" into 1965-1966 conducted gravimetric survey in Drake Strait and Scotia Sea. However, the results of all these expeditions, until now, are not published.

From known data on south ocean, which we avail, this twenty points along shore of South America, carried out into 1947 with the floating of the American submarine "Conger". Furthermore, is several dozens of gravimetric points in Indian Ocean in region of the Iles de Kerguelin and Ile Amsterdam, and on the route Ile St. Paul-Australia. This is photographing, carried out with the floating of the American research vessel "Argo" in Lusiad Expedition. On Agulhas Bank south of the coast of Africa in 1962 on the vessel "Natal" was carried out gravimetric survey,

measurements taken by gravimeter "Graf-Askania, GSS-2" (Graham, Hales, 1965).

For coastal waters of antarctica, there is not not one gravimetric point, determined by foreign expeditions and published in press/printing or transmitted to the international center of data. Thereby value and the value of Soviet work immeasurably grow/rise. The gravitational field of the water area of south ocean and water of the antarctic about which we will speak further, constructed according to the results only of Soviet determinations.

End Section.

SUBJECT CODE A39D

Page 40.

Chapter III. GRAVITATIONAL FIELD OF THE SOUTHERN OCEAN AND THE LIMB ZONE OF ANTARCTICA.

The measurements of the force of gravity carried out on the water area of south ocean and in the circumlittoral zone of antarctic continent, made it possible to present the character of the gravitational field of this part of our planet.

We have comprised the schematic gravitational map/charts of south ocean and the limb zone of antarctica in the reductions in free air and Bouguer of scale 1:7 250,000 (as basis are undertaken the blank charts of the Atlantic, Indian and Pacific Ocean sectors of the antarctic, the publication GU VMF of the USSR 1962-1963). Map/charts are comprised on the basis of the gravimetric points, carried out by Soviet expeditions [1] in south ocean and in coast

of antarctica (Grushinskiy, 1969; Koryakin, Stroyev, Frolov, 1969, etc.), from data of the catalog of IFZ of the AS USSR (Catalog of gravimetric determinations.... 1962), and also based on materials, published in different publications.

FOOTNOTE [1]. All the gravimetric determinations of Soviet antarctic expeditions are given to the reference point Mirnyy, which in turn, is connected with the American grid/network of the strong points of antarctica. ENDFOOTNOTE.

These are the catalogs of gravimetric points (Helfer a.o., 1962; Autenboer, 1964; Caputo a.o.,1964; Kirton, 1965; Oura, 1965), separate points or routes with the values of anomalies on blank charts (Langron, 1966), the map/chart of anomalies in some regions (Behrendt, 1962; Graham, Hales, 1965; Behrendt, Bentley, 1968).

The representation of materials by regions by no means it is equal, the accuracy of results is also diverse. Therefore map/charts are constructed with the different sections of the isoanomalies.

Figures 8, 9, 10 depict the map/chart of anomalies in free air. At sea, if was allowed the representation of points and value of anomalies, the isoanomalies were carried out through 25 mgal. In the circumlittoral zone of antarctica and on the very continent the isoanomalies are carried out also in essence through 25 mgal, with the exception of the sections where is carried out sufficiently dense gravimetric photographing (the Shackleton and West Ice Shelves, and Enderby Land), or of sections for which field constructed according to published map/charts (the Filchner and Ross Ice Shelves). In these cases the section of isoanomalies is 10 and 20 mgal.

The map/chart of Bouguer's anomalies (Figs. 11, 12, 13) is constructed with the section of isoanomalies 50 mgal, with the exception of the Ross and Filchner Ice Shelves and Marie Byrd Land. The section of isoanomalies on these glaciers is 10 and 20 mgal.

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THE SOUTH OCEAN AND ANTARCTICA ACCORDING TO GRAVIMETRIC DATA,(U)
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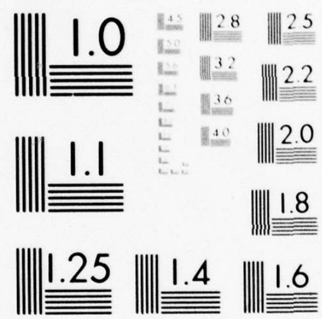


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Fig. 8. Anomalies in free air of Indian sector, mgal.

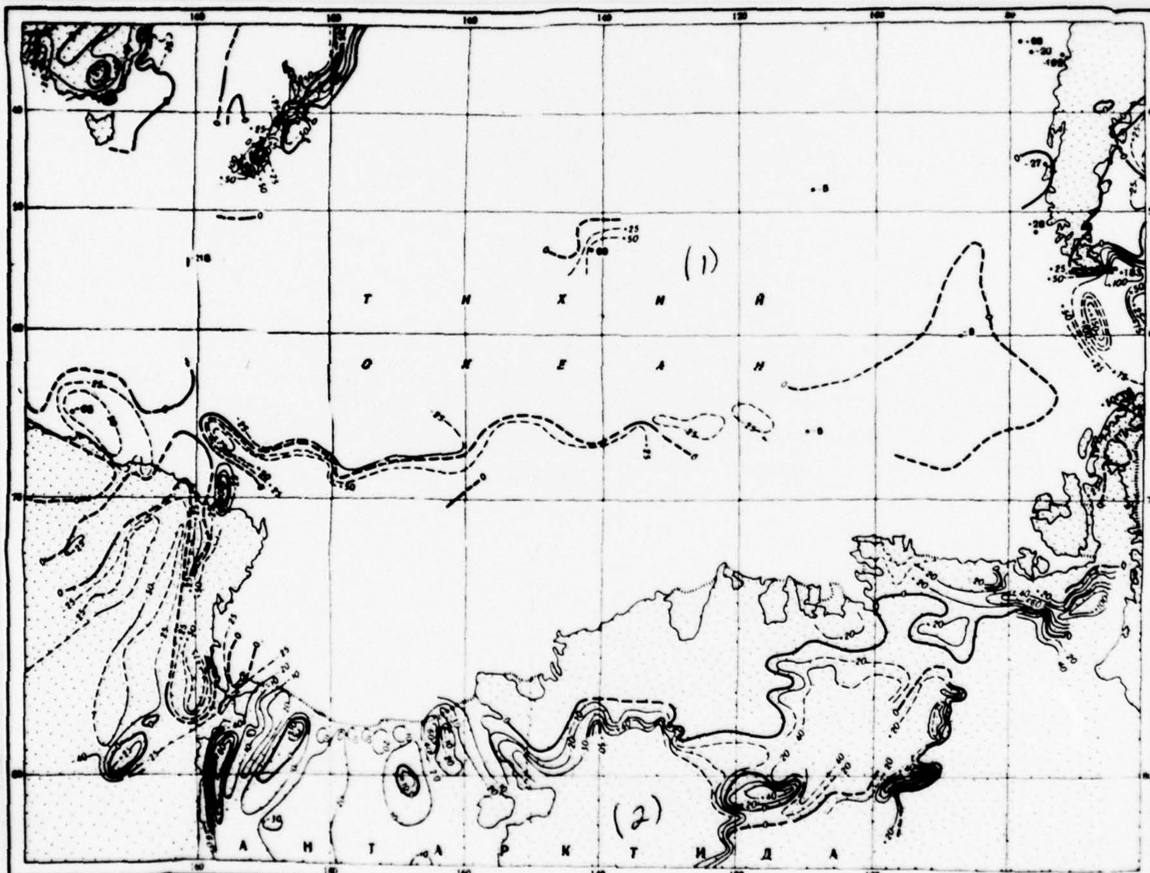
Normal formula is international. Compiled by P. A. Stroyev.

Key: (1). Indian Ocean. (2). Antarctica.

Page 40b.

Fig. 9. Anomalies in free air of Pacific Ocean sector, mgal. Normal formula is international. Compiled by P. A. Stroyev.

Key: (1). Pacific Ocean. (2). Antarctica.



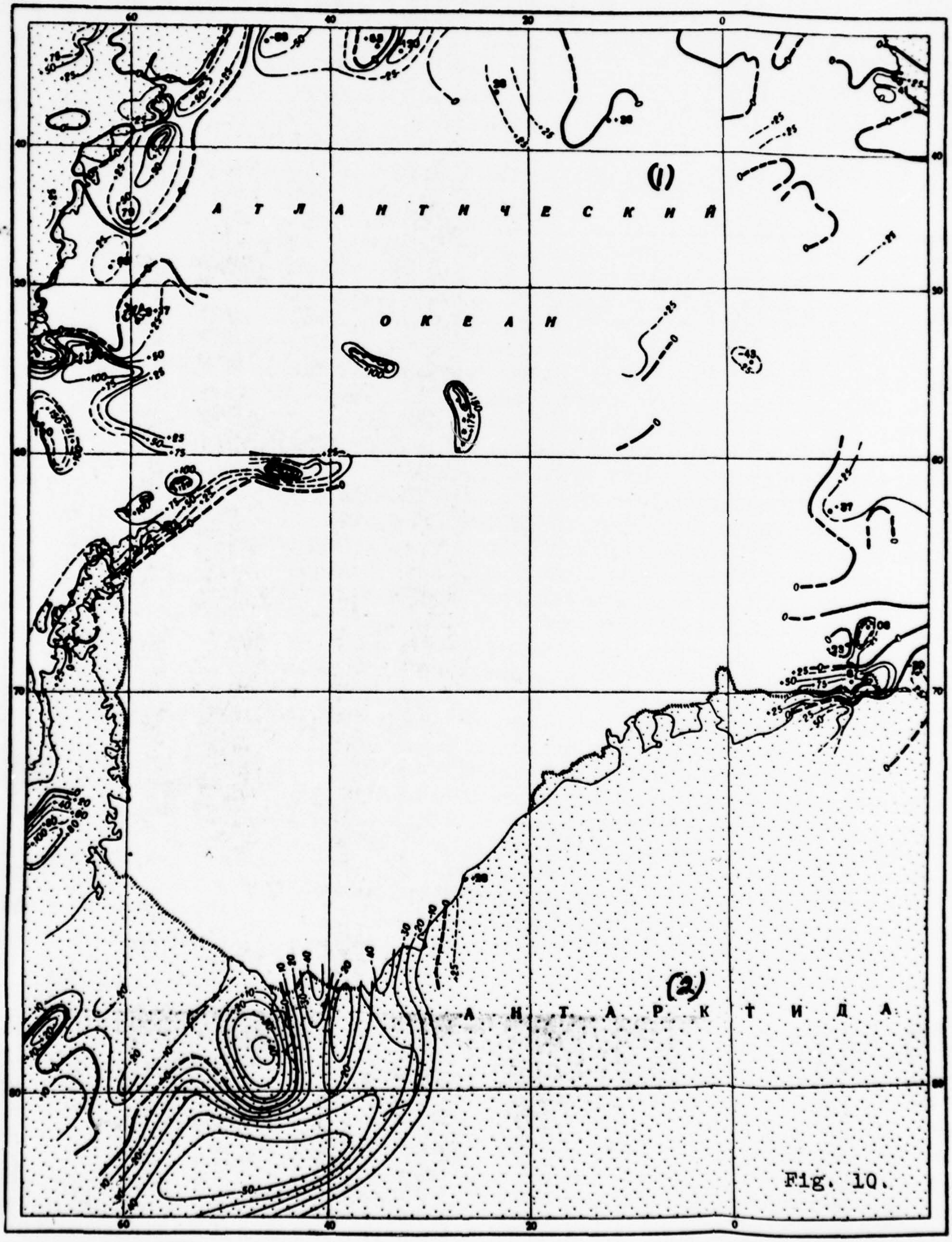


Fig. 10.

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Fig. 10. Anomalies in free air of Atlantic sector, main. Normal formula is international. Compiled by P. A. Stroyev.

Key: (1). Atlantic Ocean. (2). Antarctica.

Page 40d.

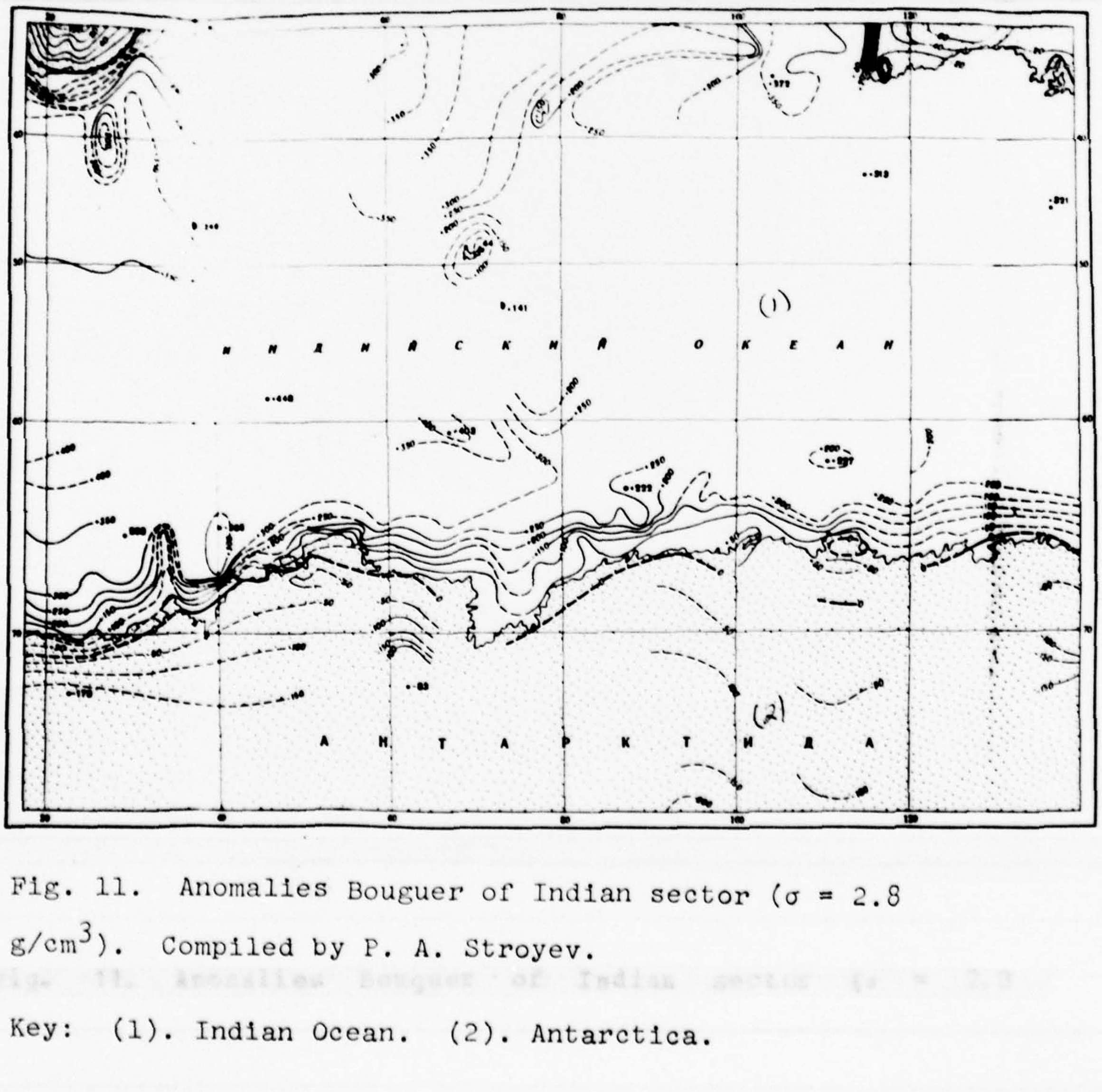


Fig. 11. Anomalies Bouguer of Indian sector (σ = 2.8 g/cm^3). Compiled by P. A. Stroyev.

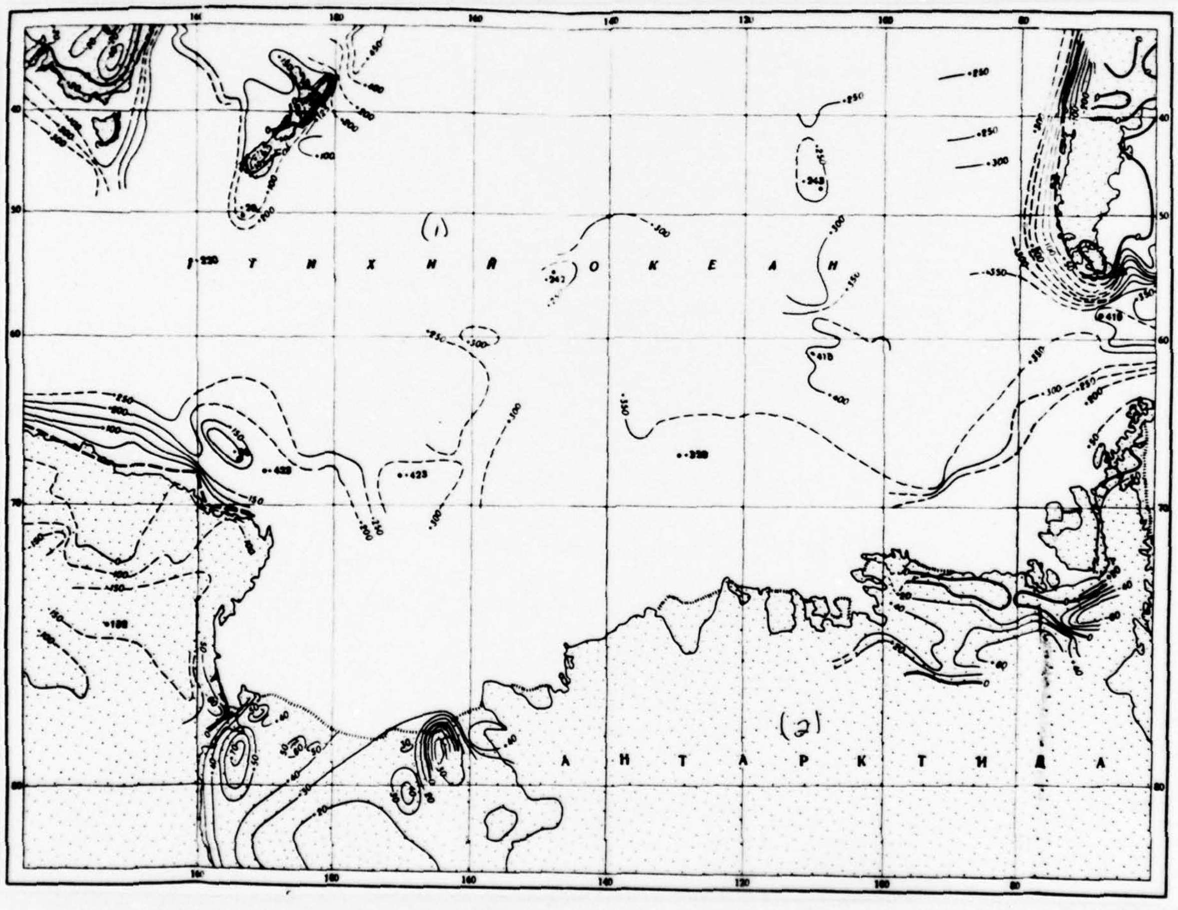
Fig. 11. Anomalies Bouguer of Indian sector (σ = 2.8

Key: (1). Indian Ocean. (2). Antarctica.

Page 40e.

Fig. 12. Bouguer anomalies of Pacific Ocean sector (σ = 2.8 g/cm^3). Compiled by P. A. Stroyev.

Key: (1). Pacific Ocean. (2). Antarctica.



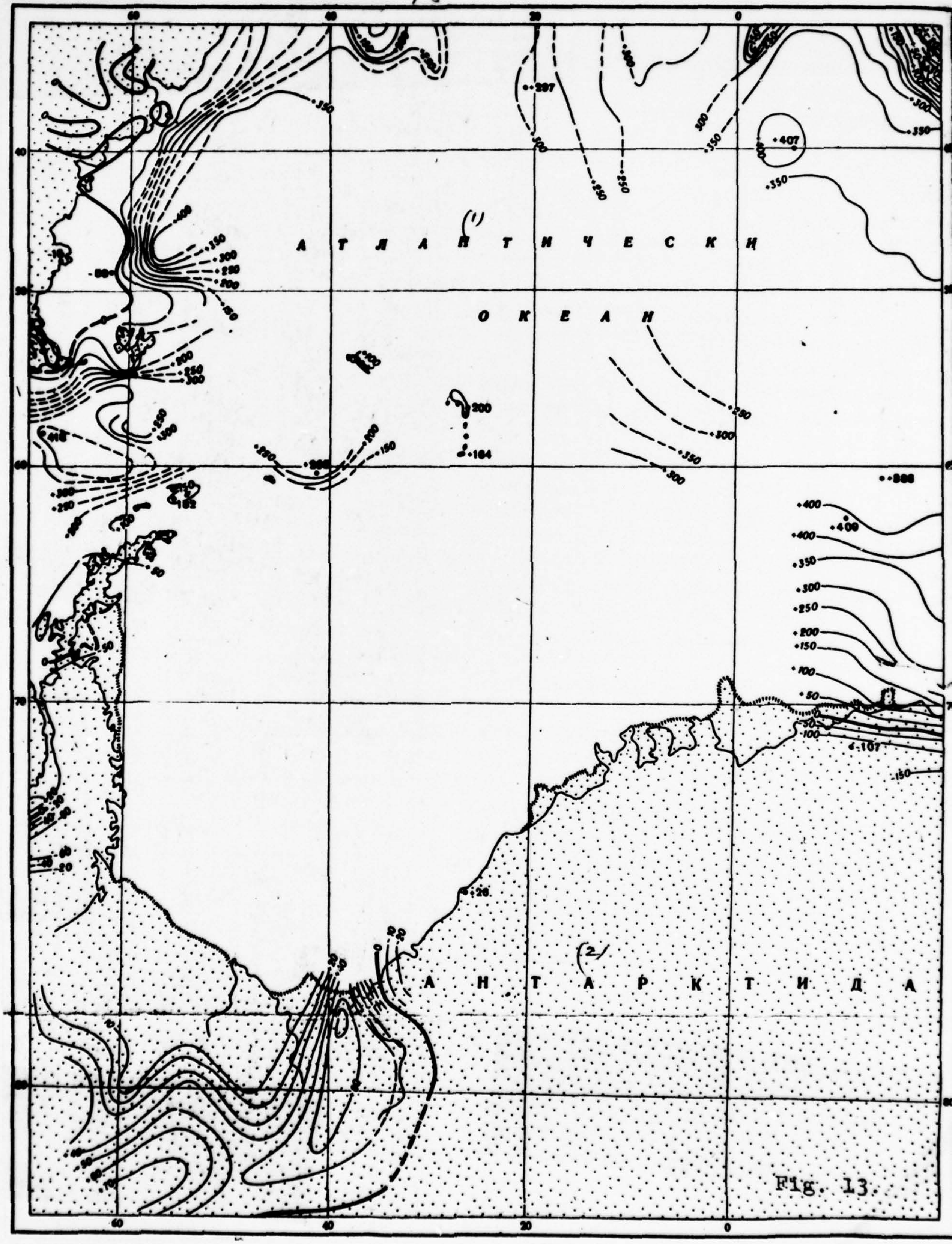


Fig. 13.

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Fig. 13. Bouguer anomalies of Atlantic sector (σ = 2.8 g/cm³). Compiled by P. A. Stroyev.

Key: (1). Atlantic ocean. (2). Antarctica.

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All map/charts are compiled by the normal international formula of the force of gravity. The density of interlayer during the calculations of Bouguer's anomalies is accepted equal to the density of basalt σ = 2.8 g/cm³.

Character of gravitational field in a south ocean.

The gravitational field of south ocean is closely related with the basic morphostructures of its bottom, the vast complexes of the relief of the sea bottom, which correspond to the specific structural cell/elements of the earth's crust. According to the character of gravity anomalies in south ocean, it is possible to isolate the following basic groups of regions.

Region of deep-water oceanic basins. Antarctica is bordered by the band of vast deep-water basins. Here enter African-Antarctic, Australo-Antarctic, Southern-Antilles Basins and the Bellingshausen Basin. The depths of basins are 4000-6000 m. The width of the band of basins varies from 150 to 2500 km. By the belt/zone of oceanic swell/rampart/rises the near-Antarctic basins are separate/liberated from the basins of south ocean, which adjoin the continents of America, Africa and Australia. These are the following basins: Southern-Pacific Ocean, Southern-Australian, Crozet, Mozambique, Agulhas, Cape, and Argentine.

The Argentine Basin is characterized by negative anomalies in free air by value from -10 to -20 mgal. Zero isoanomaly clearly contours basin. This gravitational minimum is continued to the side of shelf low water and shores of south America between 46 and 50° south latitude. Here the value of anomalies reaches -68 mgal. Bouguer's anomalies in Argentinean basin comprise more than +400 mgal in its deep-water part. In region of shelf of south America pointed out above Bouguer's anomalies have negative values, reaching value -58 mgal.

The Cape and Agulhas Basins are noted by small positive and negative anomalies in free air. The average value of anomalies is close to zero. Bouguer's anomalies here reach value +400 mgal.

The African-Antarctic basin for all its extent/elongation is characterized by positive (to +100 mgal) anomalies in free air and by the extremely intense (to +450 mgal) positive anomalies of Bouguer. The Australo-Antarctic Basin is also noted by positive (+20-+30 mgal) anomalies in free air and by the intense positive (+350 mgal) anomalies of Bouguer.

For the Mozambique Basin are characteristic negative (to -80 mgal) anomalies in free air and the intense positive (to +370 mgal) anomalies of Bouguer, the Crozet Basin is characterized by small positive anomalies in free air and by Bouguer's intense positive anomalies.

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The Western Australian Basin is noted by considerable

negative (to -70 mgal) anomalies in free air. This belt/zone of negative anomalies is stretched in the southeast direction into the Southern-Australian Basin, where the values of anomalies are equal to -10 to -20 mgal, and from there this band departs to the basin of the Tasman Sea where the average value of anomalies is -20 mgal.

The field of Bouguer's anomalies in Western Australian and Southern-Australian Basins is characterized by considerable positive (+300-+350 mgal) anomalies.

The Bellingshausen and Southern-Pacific Ocean Basins are separate/liberated by the small positive and small negative anomalies in free air and by the intense (more than +350 mgal) anomalies of Bouguer.

Oceanic uplift/rises and mid-oceanic ridges. To north from the abyssal basins, which border antarctica, are arrange/located the oceanic spine/ridges, which form the peripheral circuit of the uplift/rises of the floor of south ocean. Morphologically these are the single wide (1500-2000 km) mountain belt/zone, which has the separated form and carrying on its surface numerous lumps, spine/ridges and volcanos. The overall length of this

belt/zone within the limits of south ocean is approximately 120 thous. km (Zhivago, 1967).

Besides the single belt/zone of underwater ridges, on the water area of south ocean are vast by area underwater elevations - Agulhas, Crozet and New-Zealand Plateaus, and the Rio Grande Rise. Furthermore, are underwater ridges, oriented in meridional direction. These are spine/ridges Madagascar, Macquarie, Whale, Kerguelin.

All these structural cell/elements of the earth's crust, which are expressed in the relief of the sea bottom, find their representation, also, in the character of gravitational field. The Southern-Atlantic spine/ridge is characterized in essence by the increased positive (to +37 mgal) anomalies in free air. Bouguer's anomalies, on the contrary, have the lowered/reduced values in comparison with abyssal basins. The isoanomaly +250 mgal clearly contours the region of median spine/ridge. On the very spine/ridge of Bouguer's anomaly, sometimes they decrease to +150 mgal.

The African-Antarctic and Western-Indian spine/ridges are also characterized by the increased positive anomalies in free air (to +50 mgal). Bouguer's anomalies here reach

values +300-+325 mgal. However, the intersections of these mid-oceanic spine/ridges with the routes of gravimetric surveys completely insufficiently, and the representation of gravimetric data does not make it possible to give the sufficiently complete characteristic of these spine/ridges.

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The Central-Indian spine/ridge is separate/liberated by positive anomalies in free air to +30-+50 mgal. In the vicinities of the ridges of spine/ridge, is observed the noticeable correlation (just as on the remaining spine/ridges of rift zone of south ocean) of the topography of bottom and anomalies of the force of gravity. The strongly crushed surface of the mid-oceanic spine/ridge, which consists of the combination of small spine/ridges and narrow grabenlike depression and trenches, is characterized by the large variability of anomalies. Specifically, the anomaly above the ridges of spine/ridges they have values +30-+50 mgal; riffled valleys are noted by considerable negative (to -50 - -70 mgal) anomalies.

The Australo-Antarctic and Pacific Ocean uplift/rises are separate/liberated by the increased variable positive

anomalies against the background of the calm field of deep-water basins.

The uplift/rises and the spine/ridges of the sea bottom, not entering the system of rift zones, are also characterized by the increased positive anomalies in free air and by a decrease in Bouguer's anomalies. The elevation of Rio Grande to north from Argentine basin is noted by anomalies in free air to +50-+60 mgal, while Bouguer's anomalies reach here values +100-+150 mgal. Analogous gravitational characteristic it has the New-Zealand plateau on which, according to data of earthquakes, is establish/installed the subcontinental type of the earth's crust.

Madagascar spine/ridge, which is continuation on the bottom of ocean of mountains o. Madagascar, is characterized by positive anomalies in free air (to +20 mgal) and by Bouguer's anomalies +150-+200 mgal.

The Agulhas Plateau is separate/liberated by considerable positive anomalies in free air (to +70-+100 mgal), while Bouguer's anomalies are here +200-+250 mgal.

Underwater ridges and uplift/rises of the south ocean frequently emerge into topographic surface, forming the groups of islands (Prince Edward Islands, Iles Crozet)or islands (Iles de Kerguelin, Bouvet Oeya). The islands of volcanic origin have extremely intense positive anomalies of the force of gravity on Prince Edward Islands are observed the anomalies in free air +290 mgal, on Heard Is. +141 mgal, on Macquarie Is. +218 mgal, on Balleny Islands +146 mgal, on Tristan da Cunha +86 mgal. Bouguer's anomalies have the same order of magnitude. This value of anomalies indicates the full/total/complete absence of isostatic compensation under these islands.

The Iles de Kerguelin, one of the most significant islands of south ocean, marries vast flat/plane plateau of beginning range Kerguelin. The gravimetric observations of Soviet, Australian and American expeditions showed that unlike other islands of south ocean Iles de Kerguelin is characterized by small positive (+30-+50 mgal) anomalies in free air and by Bouguer's the same anomalies. This fact indicates that, the earth's crust in region of the Iles de Kerguelin has structure, which differs from the structure of the earth's crust of other islands.

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Island arcs and abyssal trenches. Regions of abyssal trenches and island arcs in south ocean are characterized by the quite large in the world contrast of relief. The amplitude of the heights of land and ocean depths, for example, of the Pacific Ocean shores of south America reaches 14 km. Specifically, here are observed the most intense tectonic motions.

On the water area of south ocean, are arrange/located typical island of Southern-Antilles arc and the less expressed arc of New Zealand.

Scotia, or Southern-Antilles, Arc serves as the coupling link of the folded chains of South American of andes and Western antarctica. It consists of the insular groups, arrange/located on the underwater increase of arc and connected by underwater ridges.

Gravimetric survey, carried out on the islands of arc, showed that entire/all island arc is characterized by extremely intense positive anomalies. South Georgia Island is noted by the anomalies of order +(100-150) mgal, on scales

Clark the anomalies reach +196 mgal. The group of the south sandwich islands, younger and volcanically more active, is separate/liberated by the anomalies of order +(165-225) mgal. The South Orkney Islands are characterized by anomalies +(150-170) mgal. On the South Shetland Islands the anomalies of the force of gravity reach values +(100-150) mgal.

On all islands the outlines of the isoanomalies (on detailed map/charts) follow the structural directions of arc. The chief characteristic of the field of the anomalies of the force of gravity is the presence of extremely intense (to 25-30 Eotvos) horizontal gradients.

The group of Falkland Islands, which relates, apparently, to the continental type of the earth's crust, is separate/liberated by the weak positive (+17 mgal) anomalies in free air and by Bouguer.

Graham Land and the Palmer Archipelago as south end of the island arc relating, apparently, to the transitional type of the earth's crust, are characterized small positive +(30-50) mgal by the anomalies of the force of gravity: on east shore of Graham Land the value of anomalies decreases to zero.

Graham Land is separate/liberated from the Falkland Islands and Tierra del Fuego by the Drake Passage. The bottom of spill/strait has complex structure. Along with the deep-water sections of the depressions here are encountered many mountains and the spine/ridges majority which it has volcanic origin.

The gravitational field of Drake Passage is characterized by considerable positive gravity anomalies. In the region of I. de los Estados and Birdwood Bank the anomalies in free air reach values +183 mgal, Bouguer's anomalies have approximately the same values. South of Tierra del Fuego is noted the elongated in direction from the northwest to the southeast considerable positive anomaly with values to +160-+190 mgal. Bouguer's anomalies reach here values +400 mgal. Between the Falkland and South Shetland Islands the anomalies in free air decrease to +20-+40 mgal, Bouguer's anomaly here are +250-+300 mgal, i.e., the character of field is completely analogous to the gravitational field of oceanic uplift/rises.

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To the east of Drake Passage there are no gravimetric data as yet; to west in Pacific Ocean of anomaly, they become characteristic for oceans: small positive and negative anomalies in free air and Bouguer's intense positive anomalies.

On north and in the south of Drake Passage are noted the zones of the considerable gravitational gradients.

Abyssal trenches, which border the Southern-Antilles island arc from outer, oceanic side, unfortunately gravimetrically are not described. There is only one gravimetric point to the southeast of South Orkney Islands. Ocean depth here is 6000 m. Anomaly in free air is equal to -183 mgal, Bouguer's anomaly (with the correction of Bouguer by the formula of plane-parallel layer) +262 mgal, i.e., gravitational characteristic typical for abyssal basins of island arcs of such type. Analogous anomalies are characteristic for the Kurile-Kamchatka and Aleutian basin/depressions in the northwestern part of Pacific Ocean (Gayanov, Isayev, et al., 1970).

The less indicative island arc of south ocean is region of New Zealand. New Zealand is the south link of the grandiose circuit of the island arcs, which accompany the east shores of Asia and Australia. The island arcs of the western part of Pacific Ocean will bear on themselves all the morphostructure special feature/peculiarities of arcs, namely, island arc, abyssal trench on the outer side of arc and boundary/edge swell/rampart/rise. They all are developed on transient and oceanic type crust.

The structure of the islands of New Zealand is close to the structure of continent. In the west of island, they border on the bottom of the Tasman Sea which has clearly the oceanic type of crust. To the south the continuation of islands is shallow New-Zealand plateau with the scattered on it islands. Still southr than plateau transfer/converts to underwater ridge - Macquarie Mountains - which were lengthened curved from 50 to 60° south latitude, where they cut the uplift/rises of mid-oceanic ridges and further of antarctic continent are continued for the group of the Balleny Islands. Arc is elongated to the side of Indian Ocean, on outer side arc border abyssal trenches with depths more than 5800 m.

The Kermadec and Colville spine/ridges are characterized by the increased positive anomalies in free air to +70-+100 mgal, Bouguer's anomaly here are +200-+250 mgal. Abyssal trench Kermadec is noted by intense negative anomalies in free air by value to -210 mgal and by Bouguer's anomalies +(200-300) mgal. To the east and the west from island arc in the region of the deep-water oceanic basins of anomaly in free air, have the small values of different sign (±20 mgal). Bouguer's anomalies reach here values +350-+400 mgal.

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The insular group of New Zealand is separate/liberated by negative anomalies in free air to -50 mgal on the basis of the central axis of islands. The circumlittoral zones of islands are characterized positive to +50 mgal by anomalies in free air. The minimum of Bouguer's anomalies (to -100 mgal) is noted on all islands, and only in the narrow coastal band of Bouguer's anomaly positive, but also do not exceed +75-+100 mgal.

Underwater New Zealand ridge and the Balleny Islands are characterized by intense positive (+218 mgal on Macquarie Island, +150 mgal on Balleny Islands) by anomalies

in free air and the same value by Bouguer's positive anomalies. Abyssal trench to the west of Auckland Is. is noted by negative (-41 mgal) anomaly in free air and by Bouguer's positive anomaly (+283 mgal). The analogous values of anomalies are observed in abyssal trench of the Balleny Is. Just as for the Southern-Antilles arc, New-Zealand island arc is contoured by isoanomalies following the main directions of arc; here are observed the extremely intense horizontal gradients of the anomalies of the force of gravity.

Abyssal trench of the Pacific Ocean shores of south America is characterized by the extremely intense negative anomalies in free air whose values reach -200 mgal, and by Bouguer's intense positive anomalies. Bouguer's isoanomalies go in parallel to the direction of trench and create considerable horizontal gradients.

Transition region from ocean to continents. Transition region from ocean to the continents includes shelf region and continental slope, which have the continental and subcontinental type of the earth's crust. These morphostructure cell/elements of the sea bottom find their into mapping gravitational field.

Wide (to 1000 km) shelf sand bar of the Atlantic shores of south America is characterized by the bands of positive and negative anomalies in free air. The field of negative anomalies on the water area of Argentine basin is changed by the band of positive anomalies. In region between 30 and 40° south latitude, the width of the band of positive anomalies does not exceed 200 km. In the region of continental slope, negative anomalies -(20-50) mg are sharply changed by positive anomalies +(20-50) mgal, creating horizontal gravitational gradient on the order of 5-6 Eotvos. Directly of shore positive anomalies are changed by the sufficiently wide zone of small negative anomalies. This zone cover/coats the significant part of the La Plata lowland on continent.

In region of San Matias Gulf and Bahia Blanca the width of the zone of positive anomalies in free air is increased to 900-1000 km. The value of anomalies is increased to +75-+120 mgal. Of shore itself the zone of positive anomalies is changed by the bands of negative -(10-5) mgal of the anomalies, elongated in parallel to shore.

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To the south, between 45° south latitude and group of Falkland islands is observed the considerable minimum (to -68 mgal) of anomalies. This minimum goes here from Argentine basin, although the depths of sea here do not exceed 150 m. In all probability, this minimum of anomalies is connected with great thickness (more than 6 km) of the sedimentary rocks, discovered in this region by seismic work (Wollard, 1960). This minimum is retained on the map/chart of Bouguer's anomalies. On the remaining sections of shelf of Bouguer's anomaly, they have small positive values and are changed by negative anomalies of the edge of shore. In the region of the continental slope the Bouguer's isoanomalies become concentrated, creating considerable horizontal gradients.

Of the Pacific Ocean shores of south America, in region of the development of abyssal trench, continental slope and shelf are stretched by narrow band. As it was noted above, the anomalies of the gravitational force here change very sharply, creating exclusively intense horizontal

gradients. In region of Chile trench at Valparaiso, the Bouguer anomalies change by 500 mgal at a distance 300 km (jump/drop in the heights of relief 12 km). During transition from Atlantic and Indian Oceans to the African continent, positive anomalies in free air gradually decrease to -30 mgal, Agulhas bank is noted by positive anomalies to +50 mgal. On the very continent of anomaly in free air, positive reach values +50 mgal. Bouguer's anomalies sharply decrease from +300 mgal in basin to -150 mgal in Dragon mountains. Bouguer's zero isoanomaly coincides with the shore line of continent.

In region of Western Australia, negative anomalies in free air of the Indian Ocean trench are continued to continent. In region of the Perth basin, is observed the sharp minimum (to -83 mgal) of anomalies. This minimum is connected with the omitted on faults deep depression, filled by great (more than 5 km) thickness of precipitation. Bouguer's anomalies here change extremely intensely, creating horizontal gradients more than 40 Eotvos, which indicates the sharp exchange of the character of the earth's crust.

From the Tasman Sea, regions of the negative anomalies of the basin of sea are changed by the regions of the

positive anomalies which retain their sign, also, in coast of Australian continent. Bouguer's anomalies here also sharply are changed from +350 mgal above the basin to -40 mgal on continent. Shore line follows isoanomaly +20 mgal.

Thus, it is possible to say that as a whole for a south ocean to the specific morphostructure cell/elements correspond the common/general/total lines of gravitational field. Deep-water oceanic basins are characterized by the calm gravitational field with small in value $\pm(20-30)$ mgal by anomalies in free air and by very large +(350-450) mgal by Bouguer's positive anomalies. The regions of underwater ridges and Oceanic uplift/rises are separate/liberated by positive (to +50 mgal) anomalies in free air and by the considerable (to +250 mgal) anomalies of Bouguer.

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In the vicinities of the ridges of spine/ridges, are observed the large variability of anomalies and the noticeable correlation of the topography of the bottom of sea and gravity anomalies.

For islands and the island arcs of south ocean, are

characteristic extremely intense (to +200 mgal) positive anomalies in free air and the same values of Bouguer's anomaly. Abyssal trenches are characterized by extremely intense negative (to -180 mgal) anomalies in free air. Islands with the continental type of the earth's crust are noted by small positive gravity anomalies.

In the regions of transition from ocean to continents, are observed small of the different sign of anomaly in free air. The zones of these anomalies frequently are stretched to continent, reflecting the structure of the uppermost layers of the earth's crust. Bouguer's isoanomalies in transition regions, as a rule, are congealed, are created the considerable horizontal gradients of the force of gravity, which indicates a sharp exchange of the type of the earth's crust.

Field examined above of the gravity anomalies of south ocean shows that on the average for ocean of anomaly in free air are close to zero. Exception are the zones of island arcs, abyssal trenches, and also region of Drake Passage and western part of the Scotia Sea. Hence it is possible to make the conclusion that as a whole the south ocean is close to isostatic compensation. The sections of

island arcs and abyssal trenches of south ocean of the similar to the island arcs Northern Hemisphere are distant from isostatic compensation, and here one should expect considerable isostatic anomalies.

As concerns Drake Passage, here the value of regional anomalies in free air reaches +150 mgal. Gravitational field in region of Drake Passage and Scotia Sea is constructed in essence according to the results of determinations for the diesel-electric ship "Ob'" in 1957-1958 hg, (Frolov, 1963). These observations were not very reliable due to the great effect of the perturbation acceleration, caused by the tossing of ship. However, American determinations to the south of Tierra del Fuego (Worzel, 1965) and English measurements on South Shetland Islands (Griffiths et al., 1964) confirmed the presence of considerable positive anomalies in free air. This value of anomalies allowed E. D. Koryakin to draw a conclusion about the absence of isostatic compensation in region of Drake Passage.

The analysis of the relief of the sea bottom, character and the value (normal) of Bouguer's anomalies, and also the results of deep seismic sounding showed that the earth's crust in Drake Passage and at Scotia Sea has

normal, oceanic character. No "crimes" in the structure of the earth's crust are detected. Consequently, about deviation from isostasy in Drake Passage scarcely whether there is the foundation for speaking. It seems to us that matter here in the local properties of substance of upper mantle.

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Gravitational field in a circumlittoral zone of antarctica.

Let us examine the character of gravitational field in transition zone of antarctica. To this zone are related continental slope and shelf of the sixth continent. Continental slope lie/rests within the limits of ocean depths 500-3700 m, stretching into width per 150-200 miles (Zhivago, 1967). There are narrower sections. Shelf of antarctica - this is the shallow band of the bottom, which borders entire continent. The width of shelf on the average is 80-100 miles; maximum width shelf reaches in Ross and Weddell Seas - 550 miles. However, one should add that the considerable spaces of the circumlittoral zone of antarctica are occupied with shelf and leading-out glaciers, that are

connected with the region of mainland glaciation.

Antarctic shelf has complex structure. It has the diverse complexes of the forms of relief, united into parallel to shore morphostructure forms; decreases in the relief are alternated with the elevated sections with the amplitude of heights from several hundreds to 1000 m and more.

The gravitational field of anomalies in free air of the limb zone of antarctica has complex character, reflect/representing the mainly basic features of the structure of underwater and under-ice relief.

In region of Queen Maud Land is observed the alternation of the zones of positive and negative anomalies. Each zone has sublatitudinal strike/course and it is adapted to the specific large geomorphological cell/element, moreover to each zone is noted the correlation of anomalies with the depths of the sea bottom.

South of the African-Antarctic basin with positive or close to zero by anomalies is stretched the zone of negative anomalies. The value of anomalies is changed from

-1 to -100 mgal. Within the limits of this band, is separate/liberated the zone of positive (+20 mgal) anomalies, which is necessary for underwater elevation to north from station Lazarev. Further to the south goes the band of positive anomalies. It seizes shelf on Princess Astrid Coast, in narrow band is stretched to Riiser-Larsen Sea north from Roi Baudoin Station and considerably is expanded to north from Cook Peninsula and in region of the Gunnerus Range. Anomalies correlate with the depths of the bottom of sea. If in the basin of the Riiser-Larsen Sea with depths more than 3000 m are noted weakly positive anomalies +(5-10) mgal, then to the Gunnerus Range correspond to anomaly in free air with values +(30-170) mgal.

To the region of shelf glaciers and foothills of glacier plain corresponds the band of considerable (several dozens of milligal) negative anomalies. The deep-water depression of gulf/bay lhtqov-Holm is noted by intense negative anomalies -(50-80) mgal. To the east and the west from this basin/depression of anomaly, they are increased. To the south and the east from Shirase Glacier, between Luetsow-Holm Bay and Yamato Mts. is revealed the broad band of considerable negative anomalies.

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To the southeast this band is continued under land ice. On the route of Japanese expedition, the value of anomalies reaches -40 mgal, on route 9th SAE - to -48 mgal. This band of negative anomalies notes that deep depression (with depths it is more than 500 m), separating Enderby Land from the internal parts of the continent of antarctica.

The mountain range of the western and center sections of Queen Maud Land and Soer Rondane Mts. are characterized by the small anomalies of alternating/variable sign, but on the Yamato mountain mass anomalies reach +90 mgal. To the south of Yamato Mts. in the point of the intersection of the routes of Japanese and Soviet expeditions, is observed the considerable disagreement of anomalies (see the following section). Figures 8 and 11 depict the anomaly of Japanese expedition and corrected for high anomalies of Soviet expedition. Bouguer's anomalies on this section from south to north change from -177 to +440 mgal, moreover is noticeable the sharp correlation of anomalies with relief. Outlying seas and the African-Antarctic basin are characterized by the values of anomalies +300-+400 mgal. Above underwater elevations and the spine/ridges of their

value, decrease to +(100-200) mgal. The zone of shelf glaciers is characterized by positive anomalies with values +(50-100) mgal. Foothill ice plain and the circuit of mountains of Queen Maud Land are separate/liberated by intense negative anomalies -(100-150) mgal. The elevated sections of astronauts's sea are characterized by positive (more than +80 mgal) anomalies in free air. One should assume that this zone of positive anomalies is stretched to the southeast to Prince Olav Coast and further to the east where on route 9th SAE are noted intense positive anomalies (more than +100 mgal). These anomalies correspond to under-ice mountains with heights more than 1300 m. Abyssal basins of Cosmonaut Sea are characterized by intense negative (-90 mgal) anomalies in free air. The band of negative anomalies, which is stretched from the Cosmonaut Sea to Alasheyev Bight, corresponds a deep depression of the bottom of sea, which goes in the same direction.

Coast of the western part of Enderby Land has the complex, sharply changing field of anomalies in free air (Fig. 14), which completely corresponds to the relief of basic bed. Thus, the Tange, Sakellari, and Vernadskiy Promontories and continuing at sea them of the uplift/rise of the sea bottom are characterized high, to +(70-90) mgal,

by positive anomalies. Dividing them Alasheyev Bight and Lena and Amundsen Bays are noted small positive +(10-20) mgal by anomalies in free air. The basin/depressions of under-ice relief, filled by leading-out glaciers, are characterized negative, to -(30-40) (mgal, by anomalies.

The young block mountains of Enderby Land are separate/liberated by extremely intense positive (to +170 mgal) anomalies. This indicates what the indicated region from has isostatic compensation.

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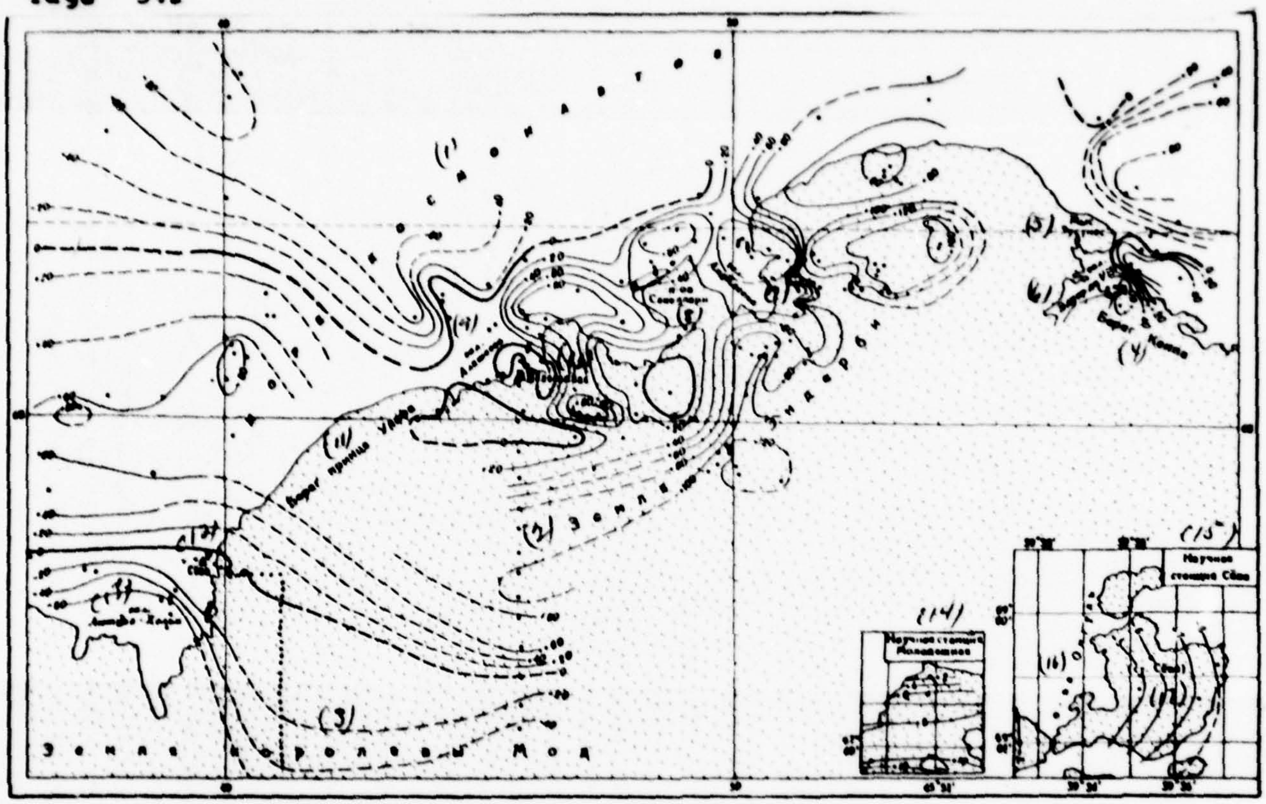

Fig. 14. Gravitational field of Enderby Land (anomaly in free air), mgal (according to Ye. D. Koryakin, P. A. Stroyev, A. I. Frolov, 1970). Key: (1). Cosmonaut Sea. (2). Enderby Land. (3). Queen Maud Land. (4). Kemp Coast. (5). Cape Eustnes. (6). Edward VIII Bay. (7). Amundsen Bay. (8). Sakellari Peninsula. (9). Alasheyev Bight. (10). Molodezhnaya. (11). Prince Olav Coast. (12). Showa. (13). Luetzow-Holm Bay. (14). Scientific station Molodezhnaya. (15). Scientific station Showa. (16). Ongul Is. (17). Showa.

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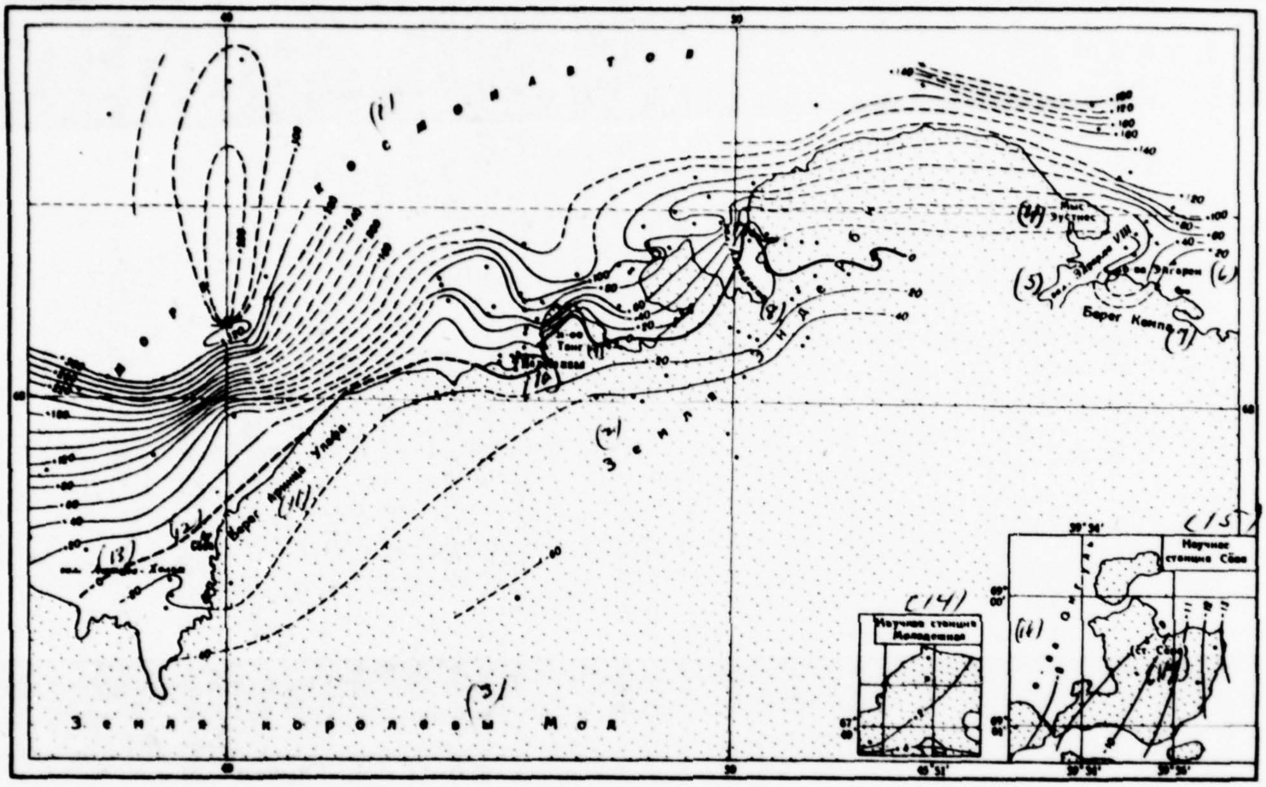

Fig. 15. Gravitational field of Enderby Land (Bouguer's ancmaly), mgal (according to Ye. D. Koryakin, P. A. Stroyev, A. I. Frolov, 1970).

Key: (1). Cosmonaut Sea. (2). Enderby Land. (3). Queen Maud Land. (4). Cape Eustnes. (5). Edward VIII Bay. (6). Oeygarden Is. (7). Kemp Coast. (8). Amundsen Bay. (9). Tange Promontory. (10). Molodezhnaya. (11). Prince Olav Coast. (12). Showa. (13). Luetzow-Holm Bay. (14). Scientific station Molodezhnaya. (15). Scientific station Showa. (16). Ongul Is. (17). Showa St.

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In the east part of Enderby Land on the Oeygarden Islands (Edward VIII Bay) are noted considerable positive (more than +70 mgal) anomalies; shelf low water to the northeast from Cape Eustnes is also characterized by intense positive (more than +90 mgal) anomalies, but the dividing them narrow and deep (more than 1500 m) basin/depression is noted by a clear minimum of anomalies (to -70 mgal).

The field of Bouguer's anomalies (Fig. 15) has calmer character, mapping into in essence the special feature/peculiarities of the deep structure of the earth's crust. Bouguer's zero isoanomaly passes along the shore line of Prince Olav Coast, the western part of Enderby Land, and in region of Amundsen Bay departs to the depth of the center section of Enderby Land. In the zone of the continental slope of isoline, they are congealed, creating considerable horizontal gradients. In the internal regions of Enderby Land Bouguer's anomaly in essence, positive, and only high mountain masses to the south from shore in the

western part of Enderby Land are characterized by the small negative (from -20 to -40 mgal) anomalies of Bouguer.

Further by south, into the depth of continent, Bouguer's anomalies are gradually decreased to -(70-100) mgal. Of the foot of continental slope and in region of deep basins of ocean of Bouguer's anomaly they are increased to +300 mgal. Attention is drawn to a sharp increase of Bouguer's anomalies in area of Cosmonaut Sea and Luetzow-Holm Bay. This considerable gravitational gradient can be caused by an abrupt change in the thickness of the earth's crust (at a distance of 50 miles it changes on 15 km) or by the exchange of the units of the earth's crust with sharply different density.

Furthermore, on the map/chart of Bouguer's anomalies is visible the elongated in meridional direction region of Bouguer's relatively lowered/reduced anomalies at sea of the astronauts, to north from the zone of high gradients pointed out above, moreover this region is not noted by an increase in the relief of the sea bottom. If a decrease in Bouguer's anomalies is caused by an increase in the thickness of the Earth's crust, then probably that these are the "roots" of the ancient buried folding, analogous to

Gunnerus Range and the Maud elevation, which is stretched of in parallel to these structures and by that cut off by the repeated onsets mainland glacier. The absence of increases in the relief of the bottom of sea in the place of the thickening of the earth's crust testifies to the isostatic lack of balance of these sections.

Prydz Bay on Princess Elizabeth Land is one of the largest gulf/bays in antarctica. This gulf/bay together with the Enderby Glacier is the enormous depression, elongated in submeridional direction and which gashes antarctic continent for the extent/elongation of more than 100 km. The field of anomalies in free air is here characterized by considerable complexity. The values of anomalies vary from +80 to -60 mgal, moreover the zones of positive anomalies are changed by the zones of negative anomalies, creating considerable (40-60 Eotvos) horizontal gradients. Anomalies noticeably correlate with the depths of sea and in essence reflect the complexity of underwater and under-ice relief.

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So, to the uplift/rise of the sea bottom in the northeast part of Prydz Bay (Four Ladies Bank) corresponds the zone

of positive (to +78 mgal) anomalies. To shelf low water north of Cape Darnley correspond tc anomaly +(30-60) mgal. Considerable depths (more than 500 m) in MacKenzie Bay are noted by the zone of negative (to -60 mgal) anomalies. Abyssal basin to north from Polar Record Glacier is also separate/liberated by the zone of negative anomalies. The Vestfold Oasis in regicn of Davis Sta. is characterized by positive (more than +70 mgal) anomalies in free air.

Bouguer's anomalies in Prydz Bay have smooth, are calm character, isoanomalies repeating the outlines of gulf/bay and just as gulf/bay, considerably they submerge into the depth of continent. The value of Bouguer's anomalies varies from 0 to +160 mgal in the very Prydz Bay; it is northern, in region of continental slope and deep-water basin, Bouguer's anomalies are increased to +(250-350) mgal.

Very is studied in detail gravitational field in region of Pravda Coast. As in other places of antarctic coast, the field of anomalies in free air is characterized by exceptional complexity, changing from +135 mgal in region of Pobeda ice island to -91 mgal on Shackleton Glacier. The

zones of the positive anomalies, elongated in parallel to shore, are changed by the zones of negative anomalies, reflecting the basic morphostructure special feature/peculiarities of the relief of the bottom of sea and the bedrocks under shelf glaciers.

The West Glacier is characterized in essence by the positive anomalies whose average value from +25 to +30 mgal. The Zavadovskiy, Mikhaylov, and Leskov ice domes, the region of Cape Maksimov and Chelyuskintsev Peninsulas are separate/liberated by considerable (from +50 to +85 mgal) positive anomalies. South of the ice islands of Mikhaylov and Zavadovskiy to the side from Philippi outlet glacier is stretched the band of negative anomalies, the minimum of anomalies reaches -42 mgal. The western part of the glacier is noted by anomalies from +15 to +20 mgal.

Anomalies of the force of gravity at Davis Sea in essence negative. The minima of anomalies are adapted to the sections of the greatest depths. In essence by negative anomalies is characterized the western part of the Shackleton Ice Shelf. However, anomalous field on this section has sharply alternating/variable character, and the values of anomalies vary from -90 to +87 mgal. The

northwestern part of the glacier at Cape Vize, in the region of which the depths do not exceed 150-200 m, is characterized by positive (from +37 to +45 mgal) anomalies. More southerly stretches the zone of negative anomalies, within limits of which by positive values are characterized only dome ice islands - Masson, Henderson and narrow band, which is stretched to west from Malygintsev Bay. In the east part of the Shackleton Glacier, where the gravitational field is studied less in detail than in western, is establish/installed analogous law. Glacier dome islands - Mill and Bowman - are characterized by positive anomalies, whereas southr is stretched the curved band of negative anomalies.

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The Bunger and Obruchev oases, within limits of which stone rock/species emerge to surface, are characterized by considerable positive (to +85 mgal) anomalies.

To the south from the peaceful, is stretched the vast band of positive (to +100 mgal) anomalies in free air, which of the 70th parallel is changed by the zone of negative anomalies, which exits to the southeast, to Wilkes

Land. Still further to the south, on route Mirnyy - Pionerskaya - Vostok, zones of positive anomalies are alternated with the zones of negative anomalies.

Bouguer's anomalies in region of Pravda Coast vary from +300 to -100 mgal. The character of Bouguer's anomalies is somewhat complicated in region of the West Ice Shelf. Chelyuskintsev Peninsula probably is the result of changing the thickness of the Earth's crust. Entire/all area of West Ice Shelf is characterized by Bouguer's anomalies +(80-100) mgal, while the Davis Sea and the western part of Shackleton Glacier have anomalies of Bouguer of order +(30-50) mgal. This difference is interpreted by us as effect of the Moho surface; however, is not excluded the probability that it is caused by a change in the density of the earth's crust or upper mantle.

The Bunger and Obruchev oases are characterized by Bouguer's positive anomalies, to +(65-70) mgal, and by close to them in value anomalies in free air (to +85 mgal). Consequently, the values of isostatic anomalies in region of the Bunger and Obruchev oases must be on the average close to +70 mgal. This is confirmed by the calculation of the isostatic anomalies whose value was +68 mgal. This high

value of isostatic anomalies makes it possible to consider that region of the Bunger and Obruchev oases is distant from isostasy. It is not excluded also, that the considerable positive anomalies of this region are caused by close arrangement to the topographic surface of rock/species with anomalously high density. If is correct the first assertion, then region of the Bunger and Obruchev oases must be referred to the peripheral zone of the block uplift/rises, which are stretched from the Golitsyn Mountains to the Strackton and Amundsen Mountains (that is confirmed by aeromagnetic data), by very distant from isostatic compensation.

The region, arrange/located between trans-Antarctic mountains on the one hand and Gamburtsev and Golitsyn Mountains on the other (Wilkes Land and Victoria Land), is characterized by from other sections of the limb zone of east antarctica the unusual gravitational field, characteristic feature of which is predominance over the vast areas of intense negative anomalies.

If on the sections of shelf and in the circumlittoral zone of continent to 70° south latitude still are observed considerable positive anomalies, then to the south from the

70th parallel on larger part of Wikles and Victoria Lands predominate the negative anomalies whose value reaches to -100 mgal.

Bands of positive anomalies are adapted to the uplift/rises of under-ice relief, zone of negative anomalies correspond to intermountain basin/depressions and the depression of under-ice bed.

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However, although the significant part of the value of anomaly is caused by the special feature/peculiarities of the structure of relief, main role here play deeper factors. So, vast by area minimum in the d'Urville Sea with anomalies to -(50-60) mgal in essence coincides with shelf shallows, although deep basin/depressions of leading-out glaciers are characterized by a considerable decrease in the anomalies. For example, the discharge opening of the Ninnis outlet glacier is characterized by the value of anomaly -69 mgal, and in Cooperation Bay is noted anomaly -145 mgal.

Trans-Antarctic mountains are characterized by the considerable positive anomalies in free air whose value here

reaches +190 mgal (Queen Maud Mts.). However, even, here intermountain sections with a small decrease in the heights are noted by negative (sometimes considerable) anomalies. This it indicates the complex dependence of anomalies not only on relief, but also on the deep structure of the earth's crust.

Bouguer's anomalies on Wilkes and Victoria Lands bear smoother, calmer character. On maritime portions the value of anomalies changes from 0 to +280 mgal, on continent - from +80 to -200 mgal. In the region of the continental slope the isoanomalies are congealed, creating considerable (15-20 Eotvos) horizontal gradients. Zero isoanomaly approximately corresponds to shore line. Further to the south into the depth of the continent of the value of anomalies, slowly they decrease. Attention is drawn to the band of Bouguer's positive anomalies between 67 and 69° south latitude on route Wilkes Sta. - Vostok Sta. Nowhere in east antarctica at this distance from shore, are encountered positive anomalies. Here this band is stretched on latitude at a distance of more than 250 km; the values of anomalies reach to +95 mgal, especially as on Budd Coast is stretched the band of negative anomalies, which separate/liberates zone mentioned above from the field of

positive anomalies in circumlittoral part. In the sense of under-ice relief, this section especially in no way differs frcm other sections of route. Consequently, the source of this anomaly lie/rests at the earth's crust or its lower than bottom. The complex of geologic geophysical investigations in this region is shown complex geologic structure, the block tectonics of the crystal basement of the antarctic platform which create the considerable anomalies of geophysical fields (Walker, 1966).

To the east from the belt/zone of trans-Antarctic mountains, on the Ross Ice Shelf and its islands where the heights of glacier are changed insignificantly, predominate negative anomalies in free air with average values from -20 to -30 mgal. And only in two places - above the basin/depression with depth 1000 m and above the island with depth 100 m - anomalies comprise with respect 69 and to +34 mgal.

Bouguer's anomalies on Ross Glacier are positive. They vary from +20 to +70 mgal. The section cf glacier to west from Roosevelt Island is separate/liberated by negative (to -30 mgal) anomalies.

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The gravitational field of Western antarctica is characterized by very large changes in the anomalies from -70 to +150 mgal. However, the anomalies of one sign are not spread to large areas. The greatest gradients are observed in region of Sentinel and Ellsworth Mts. where their values reach 100-200 Eotvos. To 100 and more Eotvos are noted the gradients above the Horlick Mountains at the edge of a deep trench.

In the northern part of Marie Byrd Land, the regions of negative anomalies are changed by the zones of positive anomalies. The Rockefeller Plateau is characterized by negative (to -70 mgal) anomalies; plateau in region of Byrd Sta. is noted by the zone of positive (to +60 mgal) anomalies. On Walgreen Coast also are alternated the zones of positive and negative anomalies, reflect/representing mainly the special feature/peculiarities of under-ice relief.

On Ellsworth Land the anomalies in free air have the analogous character: the zones of positive (to +100 mgal) anomalies are changed by the zones of negative (to -40 mgal) anomalies.

The basin/depression of the Filchner Ice Shelf is characterized by negative anomalies in free air. The Berkner and Korf elevations which are located on the uplift/rises cf under-ice relief, are separate/liberated by positive anomalies. As a whole on the glacier of anomaly, they change from -58 to +63 mgal.

Bouguer's anomalies in Western antarctica are represented leaner in comparison with the field of anomalies in free air due to insufficient study of under-ice relief. On Ellsworth Land, the zones of positive (to +60 mgal) anomalies are changed by the zones of negative (to -60 mgal) anomalies.

On the Filchner Glacier, Bouguer's anomalies positive, their value reach +70 mgal. The nunataks on Luitpold Coast are characterized by negative (to -20 mgal) anomalies.

After feeding the result of the characteristic of gravitational field in the limb zone of antarctic continent, it must be noted that the anomalies in free air clearly record/fix sharp local variations in the relief of stone

rock/species and they make it possible to isolate the raised or omitted units of the earth's crust on the sections, covered with mainland or shelf ice. The geomorphological special feature/peculiarities of the structure of the bedrocks in boundary/edge and especially in shelf zones (presence under the glaciers of considerable elevations and deep basin/depressions and trenches) create the high gradients of anomalies. The vast fields of intense positive and negative anomalies in limb zone indicate the absence of isostatic compensation these sections. However, comparatively low values of positive regional anomalies in the central regions of continent, intense negative anomalies in intermountain basin/depressions, small negative anomalies in valleys in the presence of intense positive anomalies in limb zone and above large mountain masses, generally speaking, correspond to the circuit of regional isostatic compensation. It is hence necessary to assume that as a whole antarctica is close to isostatic compensation.

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The crust of the center section of the antarctic continent caved in under ice load, after displacing heavy subcrustal masses to limb zone. On this, testify the bands of

positive and negative anomalies, which are pulled in sublatitudinal direction in parallel to the configurations of continent.

Systematic errors during gravimetric investigations in antarctica.

The measurements of the force of gravity in the circumlittoral zone of antarctic continent are conducted with the aid of gravimeters, the height of points they are determined by the method of barometric leveling, coordinate - in an astronomical manner and a numeration. In view of the special conditions of work in antarctica it is possible that data of some expeditions contain considerable systematic errors because of the errors of barometric height and in smaller measure because of the errors strictly of gravimetric determinations.

During mapping of gravitational field to this fact by us was directed special attention, in connection with which was carried out the analysis of the results by means of the comparison of these different expeditions in the points

of the intersection of routes or on the closely spaced points. Such errors were reveal/detected in the results of some Soviet and foreign expeditions. In certain cases when independent direct/straight or indirect data of errors are present, they were establish/installed and were taken into account.

The unprecedented even for Antarctica fact of the disagreement of the values of the heights of the surface of glacier and anomalies of the force of gravity have reveal/detected we in the circumlittoral zone of east Antarctica (Stroyev, Frolov, 1970). On Queen Maud Land, south of Showa Sta. in region 74.5° south latitude and 38.4° east longitude intersect the routes of the expeditions of Japanese expedition into 1961 and 9th SAE into 1963-1964. The difference in the average values of heights at isolated points near the point of intersection of the routes is 310 m, while a difference in the anomalies of the force of gravity is about 140 mgal. The results of the measurements of these expeditions are represented in table 3, where ϕ is the southern latitude, λ is east longitude, $H_{ледн.}$ is height of the glacier above sea level, $H_{к.п}$ - height of stone rock/species according to data of seismic soundings (SZ) (on the points of Japanese route data SZ

are not published), $g_{набл.}$ - the observed value of the force of gravity expressed in the system of American strong points, Δg - the anomaly with reduction in free air, obtained from the international formula of normal values.

Collating data tables 3 on two expeditions, we see that in essence the difference in the anomalies, which reaches on the nearest points 4-5 and 4'-5' ~140 by mgal, is caused by altitude difference.; however, even, those who were observed value $g_{набл.}$ diverge on 35-40 mgal.

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Since the observation stations are not accurately combined, but difference of heights systematic, difference $g_{набл.}$ can be caused only by the structure of the bed of glacier, i.e., by altitude difference of stone rock/species $H_{к.п.}$ which at a distance 5-6 km must be about 450-500 m. Similar jump/drops in the heights in the mountainous regions of antarctica are possible, but systematic deviation on the extended section it indicates the groundlessness of a similar explanation in this case.

We examined in detail all the published materials, and

are also discussed the results of work 9th SAE with some participants of this expedition. The results of the work of Japanese expedition were discussed with Japanese scientists, unfortunately not with the executors of these investigations.

It is establish/installed that the heights of points by Japanese expedition 1961 on section from Showa Station to Yamato Mountains and further to 75° south latitude are determined by the method of route barometric leveling s with support to one station, Showa. The accuracy of heights cn the first section where are carried out repeat measurements, they are estimated at error ±10 m. On the second section, in the opinion of author (Oura, 1965), are possible the errors to 80 m.

Table 3. Comparison of the results of the gravimetric measurements of Japanese and Soviet expeditions.

№ пунктов (1)	φ	λ	$H_{ледн.}$, м	$H_{к.п.}$	$g_{набл.}$, мгл	Δg
(2) Японская экспедиция, 1961						
1	74°09′	38°08′	3134	С3–19	981 873	+6
2	21	13	3159	–	840	–28
3	30	16	3168	С3–20	819	–54
4	34	17	3157	–	826	–53
5	40	19	3165	–	838	–44
6	45	22	3198	–	832	–43
7	51	24	3222	–	832	–40
8	57	26	3232	С3–21	817	–57
(3) 9-я САЭ, 1963 - 1964						
1′	74°07′	39°22′	3426	–	981 882	+106
2′	16	02	3453	–	868	+ 99
3′	25	38°42′	3482	–	858	+ 86
4′	35	24	3498	1018 м	862	+ 88
5′	42	37°53′	3523	–	873	+101
6′	50	22	3516	–	869	+ 88
7′	59	36°49′	3504	–	883	+ 92

Key: (1). points. (2). Japanese expedition. (3). 9th SAE.

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In 9th SAE on section from the Pole of Inaccessibility to Molodezhnaya Station was applied synchronous ($H_{сбн}$) barometric leveling (simultaneous readings of aneroids on two

points of route with the subsequent change in the instruments and the comparison of their readings). Extent of route - approximately 2400 km, the duration of leveling - 40 days. The obtained difference from course, equal to 140 m, is distributed evenly on points $\Delta h = -0.6n$ (Bugayev, 1965). However, late results were reexamined: heights were calculated relative to Molodezhnaya Station (H_{6H}). Altitude difference, obtained by the indicated methods, varies from -36 to -157 m. Average value $H_{c6H} - H_{6H} = -105 \pm 17$ м [1].

FOOTNOTE [1]. Here and below the errors are calculated under the condition of equal accuracy of data. ENDFOOTNOTE.

Independent control on section from Molodezhnaya Station to 68.3° south latitude is carried out on the map/chart of Enderby Land of natural size 1:1 000 000 (Atlas of the Antarctic, 1966). Elevations on map/chart are obtained by aeroradiobarometric method with accuracy ±(5-6) m. Horizontals are carried out through 100 m. Altitude difference on 4 points of this section $H_{к} - H_{саэ} = -130 \pm 20$ m.

At the end 1966, were published in the form of

curve/graphs the preliminary results of American expedition 1965-1966 (Beitzel a.o., 1966), laid route from South Pole to Pole of Inaccessibility and further for west to turning point and then through the southeast to the newly organized American Plateau Station (ϕ = 79°15' south latitude; λ = 40°30' east longitude; H = 3624 m). Routes 9th SAE and American expedition intersect at point 80°20' south latitude. American expedition also applied barometric leveling. As strong point served station the east. For the observations of air pressure, they served 12 barometers (altimeters). The values of heights we have obtained from the curve/graphs into two hands by repeated measurements with the graphic error of one measurement $\pm$(20-30) m. A difference in the average values of heights on the sections of routes of the point of their intersection render/showed on this section of systematic: $H_{AM} - H_{CAЭ} = -110 \pm 10$ m. Consequently, the direct/straight comparisons of the values of the heights, accepted 9th SAE, with the heights, obtained from other four sources from which three independent variables, show that in heights 9th SAE is reveal/detected the systematic error of order +(100-130) m.

Let us show now that and some indirect signs confirm these conclusions.

The overall statistical relationship/ratios between the anomalies of Faye and effective heights, establish/installed by A. I. Frolov for central regions and the limb zone of east antarctica, take the form:

the central regions

$$\Delta g = -25+30\,\bar{H} \;(\varepsilon = \pm 16 \text{ mgal}), \qquad (1)$$

the limb zone

$$\Delta g = 49\,\bar{H} \;(\varepsilon = \pm 18 \text{ mgal}) \qquad (2)$$

here H - effective height, km, ε - the error of equation.

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On route of 9th SAE from Vostok Station to the Pole of Inaccessibility where the heights are obtained by geodetic leveling, the dependence pointed out above takes the form:

$$\Delta g = -85+64\,\bar{H} \;(\varepsilon = \pm 14 \text{ mgal}). \qquad (3)$$

Let us use these average statistical relationship/ratios to the sections of route 9th SAE, after isolating central regions from 82° to 74° south latitude and limb zone ϕ < 70° south latitude. For the section of central zone, we have Δg = +42 mgal and $\bar{H}$ = 1.48 km. For section of limb zone Δg = +110 mgal and H = 1.20 km.

Substituting the value of $\bar{H}$ = 1.48 in formulas (1) and (3), but $\bar{H}$ = 1.20 into formula (2), we will obtain with respect Δg = +20 to mgal; Δg = +10 mgal; Δg = +59 mgal. Differences in the expected anomalies with actual will be +22, +32 and +51 mgal. On an entire route the actual values of anomalies are overstated from +20 to +50 mgal, and in average/mean by approximately +35 mgal, which corresponds to the error in height of approximately +110 m.

The investigations of the heights of geoid (Frolov, 1967) indirectly confirm the errors of data 9th SAE. In sector 30-60° east longitude of the height of geoid, obtained from defective data 9th SAE, they proved to be

overstated in comparison with the heights, brought out from observations of artificial Earth satellites, on the average cn 25 m.

Thus, straight lines and indirect proof indicate that the heights 9th SAE contain the systematic error of order +120 m.

On the basis of the results of the investigations of the height of points 9th SAE have been we corrected from 81°38' south latitude 45°33' east longitude to 75°45' south latitude 32°48' east longitude on -100 m, and of 75°39' south latitude 33°24' east longitude to 67°51' south latitude 45°48' east longitude on -125 m.

As concerns of these Japanese expedition, then is obvious only relative (according to corrected data 9th SAE) systematic error of order -180 m on the section of the intersection of routes. However, data insufficiently, and these results should leave thus far without change.

The made conclusion/derivations are confirmed by data of geodetic leveling on route 12th SAE into 1967 from Molodezhnaya Station to the Pole of Inaccessibility [1].

FOOTNOTE [1]. Simultaneously here was fulfilled barometric leveling. ENDFOOTNOTE.

This route from Molodezhnaya Station to 69° south latitude passes near route 9th SAE, somewhat east it. Difference in longitude of points is from +5 to +25', and from 69 to 72° south latitude - from +16 to +65'. Further to the south route 12th SAE retains direction in the pole of inaccessibility and far is deflect/diverted to the east from route 9th SAE.

On section from Molodezhnaya Station to 69° south latitude altitude difference on six points with equal latitudes varies from -84 to -158 m. Average value -132±4 m. Thus, on this section is confirmed the systematic error, obtained from the marks of the map/chart of Enderby Land (130 m), and is establish/installed the real random error of the taken barometric values of heights ±34 m.

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On section from 69 to 72° south latitude with the equal latitudes of altitude difference, they change from -14 to +27 m. Average difference +12 m. However, on this section from route 9th SAE to route 12th SAE, judging by the map/chart of Enderby Land, the surface of glacier noticeably it is raised to the east, and the horizontal they go under azimuths of approximately 60°; therefore the extrapolation of heights it cannot give reliable result. From 72° south latitude of altitude difference of points with equal latitudes, again become negative, reaching 125 m. But the heights of these sections scarcely whether it is possible to compare.

On route Pole of Inaccessibility - Plateau Station - point of turn of 9th SAE - Novolazarevskaya in 12th SAE heights were determined by the method of synchronous barometric leveling.

Route of 12th SAE accurately intersects route 9th SAE at the turning point of the latter. It is of interest to compare the heights of two expeditions. According to data 9th SAE in the vicinity of point of intersection medium

altitude $\bar{H}$ = 3347 m (it is direct at turning point H = 3318 m); according to data of 12th SAE $\bar{H}$ = 3317 m (it is direct at point of intersection H = 3286 m). Altitude difference does not exceed 30 m. It would seem that the heights 9th SAE do not contain considerable systematic errors (comparison it goes in all over one point). However, on route 12th SAE Pole of Inaccessibility - Novolazarevskaya is obtained difference 314 m. This value indicates that in the case of variable pressure gradient on this route, if we do not consider its effect, this can lead to significant systematic errors.

Furthermore, on route Molodezhnaya - Pole of Inaccessibility difference in the determination of heights by barometric method proved to be equal to 112 m. The comparison of the equalized barometric height on this route with geodetic heights showed that altitude differences vary from +13 to -59 m, the differences having by sections systematic character. Average on route it gives systematic difference -17 m. Without taking into account this systematic difference, is obtained the root-mean-square error in determination of heights by barometric method, equal to ±26 m.

Finally, it is interesting to compare heights at Plateau Station. In 12th SAE is here obtained the height 3686 m; according to American data (Picciotto, 1966), it is 3624 m, i.e., disagreement is equal to 62 m. Thus, and in these 12th SAE there can be errors, but into data 9th SAE the presence of the considerable systematic error does not cause doubt.

In connection with the reveal/detect/exposed altitude errors and gravitational force of points 9th SAE arises the question also concerning the reliability of the results of determining the heights of under-ice relief by this expedition.

If the results of the seismic determinations of expedition are reliable and obtained independently of the gravimetric, then the reveal/detect/exposed systematic errors in height of points will change with respect (100-125 m) and the results of the determinations of the heights of the bed of glacier.

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However, if on some points of reflection were uncertain and

"were correlated" by means of the analysis of gravimetric (also erroneous!) data, then was possible another interpretation. The executors of work (Kapitsa, Sorokhtin, 1965) note that on section from the Pole of Inaccessibility to Molodezhnaya Station an interval between the points of seismic soundings (SZ) was 200 km. Of 21 points of SZ on route Vostok - Molodezhnaya at twelve points were obtained sharp reflections; at seven mirror points, they were correlated less confidently, and determination or the selection between the axes of cophasality was necessary to make on the basis of the analysis of gravimetric data; at two mirror points, they were not obtained entirely. It is not shown that at which concrete mirror points are obtained uncertain.

All this gives grounds to assume that and in the determination of the depths of under-ice relief from route 9th SAE are considerable errors. Figures 16 depicts the circuit of under-ice relief, obtained by American scientists on the route Pole of Inaccessibility - turning point - Plateau Station. This circuit is constructed according to data of 16 points of seismic-refraction soundings and 136 gravimetric points. On this same circuit by dotted line is shown the boundary ice - stone rock/species, constructed

according to data 9th SAE (Kapitsa, 1966). As can be seen from circuit, under-ice relief in data each expeditions is characterized by significantly. Instead of the flat depression of the bed of glacier, according to data 9th SAE, from Pole of Inaccessibility Station to the Western Plain of the height of under-ice relief, according to American data, remain positive at a distance more than 450 km. The bottom of glacier has the complex, separated character, forming mountains with height more than 1200 m and basin/depression with the heights lower than sea level. In the point of intersection of routes 9th SAE and the expedition of the USA, we have disagreements in the height of under-ice relief 700 m. Under Plateau Station instead of high mountains (with marks of approximately 2000 m, according to data 9th SAE) we have positive heights 500-600 m.

Thus, Western Plain, which occupies in detailed maps (Atlas of the Antarctic, 1966; Kapitsa, 1966) enormous area, is confirmed by American investigations only for extent/elongation 150-200 km. Where on circuits (atlas of the antarctic) is shown basin/depression, are raised mountains. The isolines 1000-1500 m, which fix the Vernadskiy Mountains as continuation of the Gamburtsev

mountain system, are not confirmed. According to American data, here the heights of under-ice relief hardly reach 500-600 m.

Published data of the seismic sounding (Kogan, 1968) also confirm this assumption. Figures 16 gives the map of under-ice relief, constructed according to data the 9th and 12th SAE. In the diagram it is evident that on the 1000-kilometer route instead of mountains by height more than 1700 m (according to data the 9th SZ) is an under-ice basin/depression with marks -206 m. And only from the 1100th kilometer of route begins uplift of the basic bed of glacier. On 80° south latitude and 52° east longitude where according to data 9th SAE is designated the apex/vertex of Vernadskiy Mts. (more than 2000 m), according to data of 12th SAE, the height of under-ice relief is 1047 m.

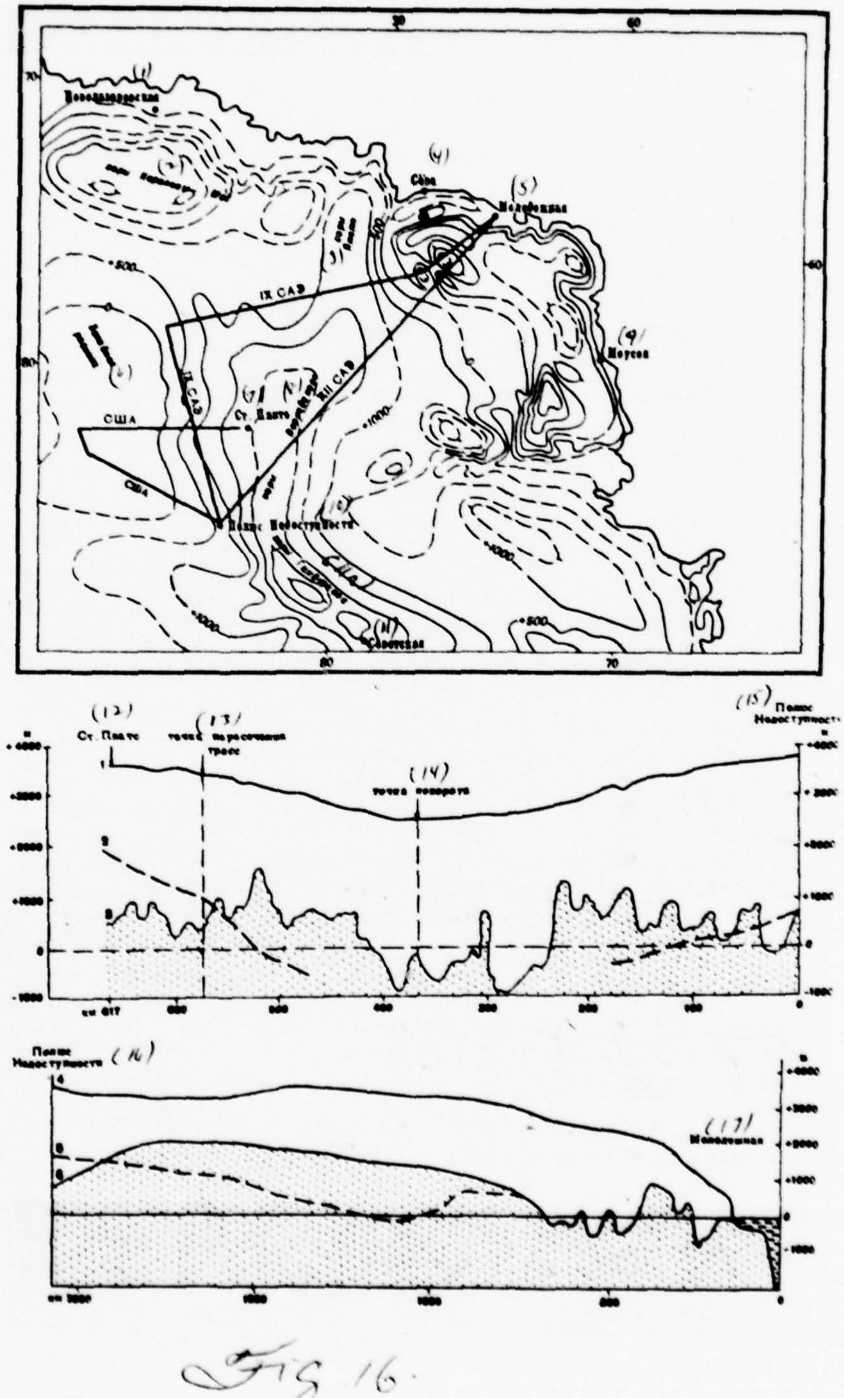

Fig 16.

Fig. 16. Map of under-ice relief 1 and 4 - relief of topographic surface: 2 and 6 - depths according to data 9th SAE; 3 - depth according to data of expedition of the USA; 5 - deep according to data of 12th SAE.

Key: (1). Novolazarevskaya. (2). Queen Maud Mts. (3). Yamato Mountain. (4). Showa. (5). Molodezhnaya. (6). West Plain. (7). Plateau Sta. (8). Vermadskiy Mts. (9). Mawson. (10). Pole of Inaccessibility. (11). Sovetskaya. (11a). Gamburtsev Mts. (12). Plateau Sta. (13). point of intersection of routes. (14). Turning point. (15). Pole of Inaccessibility. (16). Pole of Inaccessibility. (17). Molodezhnaya.

[Page 65.] It is interesting to note that at the Pole of Inaccessibility the difference in the determination of the power/thickness of glacier by two Soviet expeditions composes 840 m.

As a result of the carried out analysis, it is possible to make the conclusion that the Vernadskiy Mts. (if really/actually they there exist) scarcely whether to competently stretch in the form of mountain range in meridional direction to Cook Peninsula and the Gunnerus sand

bar. Those mountains discovered enroute can be attributed to the Yamato and Gamburtsev mountain system which are divided between themselves with considerable under-ice plains.

Some special feature/peculiarities of the gravitational field of the south ocean and antarctic its communication/connection with the deep distribution of masses of the Earth.

Besides the common/general/total lines of gravitational field, which are inherent in the specific morphostructure cell/elements of all parts of the south ocean, it is possible to note some special feature/peculiarities of field, which relate to the overall regions of the Southern Hemisphere. So, in the Atlantic sector of south ocean Argentine and Cape Basins with identical depths are characterized characterized by the different values of anomalies in free air. For the Argentine basin are characteristic negative anomalies from -10 to -20 mgal, whereas the Cape and Agulhas Basins are noted by close to zero anomalies.

Even more sharply in the field of anomalies in free air are distinguished the basins of the Indian sector of

south ocean. The African-Antarctic Basin is characterized by considerable positive anomalies, the Australo-Antarctic Basin - by small positive and by places by negative anomalies. At the same time Western Australian and Southern-Australian basins are wholly characterized by the field of considerable negative anomalies. Moreover the band of negative anomalies from Australia is stretched to the southeast into the Australo-Antarctic Basin and further to antarctic coast in region of Wilkes and Victoria Lands. Figures 17 depicts the dependence of anomalies in free air on the depths of the ocean floor for the western and east parts of the Indian sector (as approximate boundary it serves the 90th meridian). It is evident that both on the scatter of the values of anomalies for one and the same intervals of depths and of the average value of these anomalies in the appropriate intervals of depths the western part differs from the east. As a whole western part is characterized by the average value of anomalies +12 mgal, east part has the average value of anomalies -10 mgal.

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Besides this overall difference, for an Indian sector are differences in the smaller order. So, Mozambique basin

is characterized by negative anomalies, whereas adjacent Crozet Basin is noted by small positive anomalies in free air.

In the Pacific Ocean sector of the south ocean of such differences, it is not observed. The regions of positive anomalies are changed by the regions of negative anomalies within the limits of uniform morphostructure cell/elements.

Field examined above gravitational (observed on the earth's surface) will agree well with the field of the anomalies of the force of gravity obtained from the observations of artificial Earth satellites (Köhnlein, 1966). Here distinctly are separate/liberated the western (region of positive anomalies) and east (region of negative anomalies) parts of the Indian sector of south ocean. In Atlantic sector to north from 50° south latitude (region of Argentine basin) western part is characterized by negative anomalies, whereas east part is separate/liberated by the positive anomalies of the force of gravity. East antarctica to 130° east longitude is characterized by positive anomalies, whereas Wilkes Land, Victoria Land, and almost entire/all Western antarctica are noted by negative anomalies.

The examined anomalous regions occupy vast spaces of the earth's surface and are not connected with the basic cell/elements of the relief of the earth's surface both in the sense of location of these anomalies and in their intensity. The ancmalous regions of one sign lie down independently to sections both from of the continental and with the oceanic type earth's crust. Consequently, these anomalies do not depend on the structure of the earth's crust. Plausible explanation for this, obviously, is assumption (Magnitskiy, 1965), that the sources of these disturbances of gravitational field lie/rest on considerable depths at the mantle of the Earth. This does not contradict the contemporary concepts about the structure of crust and mantle of the Earth and confirms the vastness of ancmalous regions.

Basic features of anomalous gravitational field are confirmed by the map/charts of the heights of geoid. At present according to the observed data of the orbits of artificial Earth satellites by different authors are comprised the map/charts of the excesses of geoid relative to ellipsoid. Examine/considered by us the region of the

south ocean and antarctic is separate/liberated (Gaposchkin, 1966) by the intense positive (to +45 m) and negative (to -65 m) excesses of geoid. So, east antarctica (besides Wilkes and Victoria Lands), the western part of the Indian sector, the east part of the Atlantic sector of south ocean are characterized by the positive heights of geoid. The Western antarctica, Wilkes Land, Victoria Land, and also the east part of the Indian sector of scuth ocean have negative heights.

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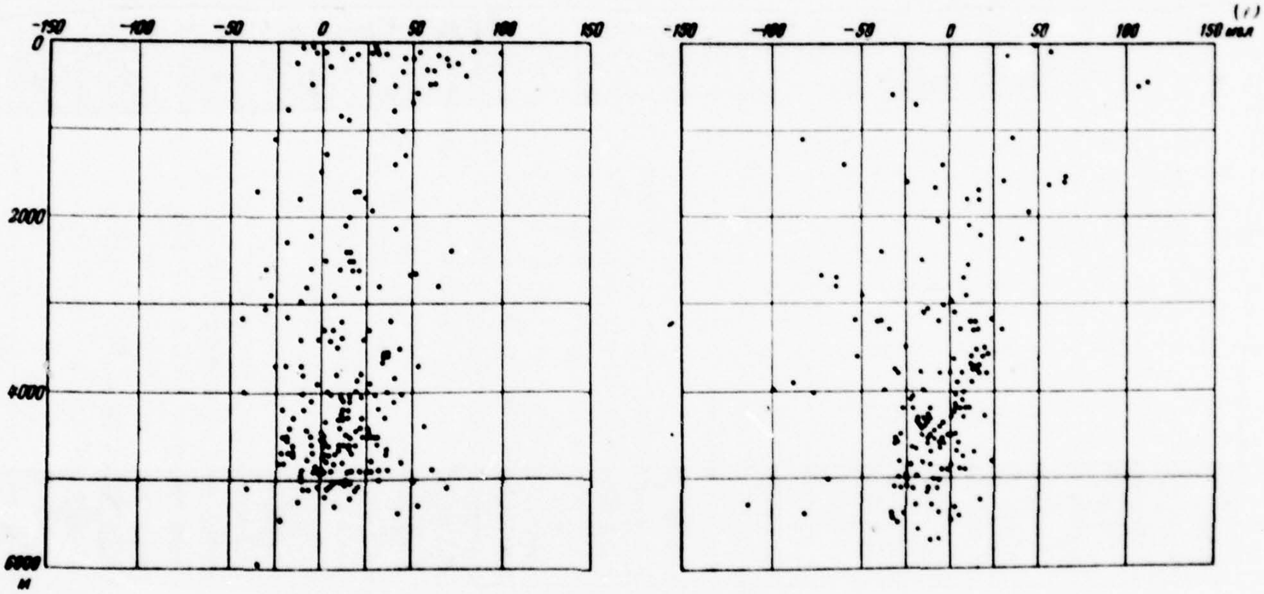

Fig. 17. Dependence of anomalies in free air on depths of bottom of Indian sector of south ocean. Compiled by P. A. Stroyev

a) the western part:

$H = 3000 \div 4000$ м: $\Delta g = +15$ mgal;
$H = 4000 \div 5000$ м: $\Delta g = +10$ mgal;
$H = 5000 \div 6000$ м: $\Delta g = +10$ mgal

average $\Delta g = +12$ mgal,

b) the east part:

$H = 3000 \div 4000$ м: $\Delta g = 0$ mgal;
$H = 4000 \div 5000$ м: $\Delta g = -10$ mgal;
$H = 5000 \div 6000$ м: $\Delta g = -20$ mgal

average $\Delta g = -10$ mgal.

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The excesses of geoid relative to ellipsoid as the anomaly of the force of gravity can be interpreted from the viewpoint of the deep structure of the earth's crust and upper mantle. The waves of the surface of geoid are divided into the waves of the first, second and third orders. Largest, the first and second order of the wave of geoid are caused by the horizontal density heterogeneities of upper mantle, which cover enormous areas. Consequently, the density of the substance of the upper mantle of regions with positive anomalies and positive excesses of geoid is somewhat above, rather than the density of the mantle of regions with negative anomalies and negative excesses of geoid. A difference in the densities can reach 0.04-0.05 g/cm³. The depth of penetration of the anomalous density substance of upper mantle in the south ocean and the antarctic, probably reaches several hundreds of kilometers. On this, testifies the field of the anomalies of the force of gravity calculated according to the observations of artificial Earth satellites for heights 1000

and 10,000 km. The regions of negative and positive anomalies are retained at high altitudes, it is logical, decreasing in intensity. This confirms the considerable depth of occurrence and the vastness of the anomaly-forming masses.

There is information about the fact that in regions with the positive anomalies of the force of gravity the heat flux is somewhat lowered/reduced as compared with average world values, while in regions with negative gravity anomalies are observed the increased values of heat flux (Girdler, 1966). Is planned correlation between the gravitational field and the depths of focus of earthquakes. Regions of positive gravity anomalies are characterized by a deep seismicity (South-Antilles arc, the western outskirts of south America, African-antarctic elevation), while regions with negative gravitational field are characterized by shallow-focus earthquakes (Australo-Antarctic elevation, Southern-Pacific Ocean spine/ridge). Are reveal/detected the differences also in the distribution of volcanism.

Are observed finally the differences also in the character of the magnetic field of the Southern Hemisphere. Figures 18 gives the map/chart of world magnetic (ΔZ)

anomalies (Kropachev, Kolesova, 1967). The region of positive magnetic anomalies (to +8000γ) covers the western part of the Indian sector, the Atlantic sector of south ocean and the large part of east antarctica, the region of negative magnetic anomalies (to -4000γ) are an east part of the Indian sector, Western Australia, Wilkes Land and Victoria Land. Consequently, the regions of positive magnetic anomalies completely correspond to the regions of positive gravity anomalies, and, on the contrary, the zones of negative magnetic anomalies correspond to the zones of negative gravity anomalies.

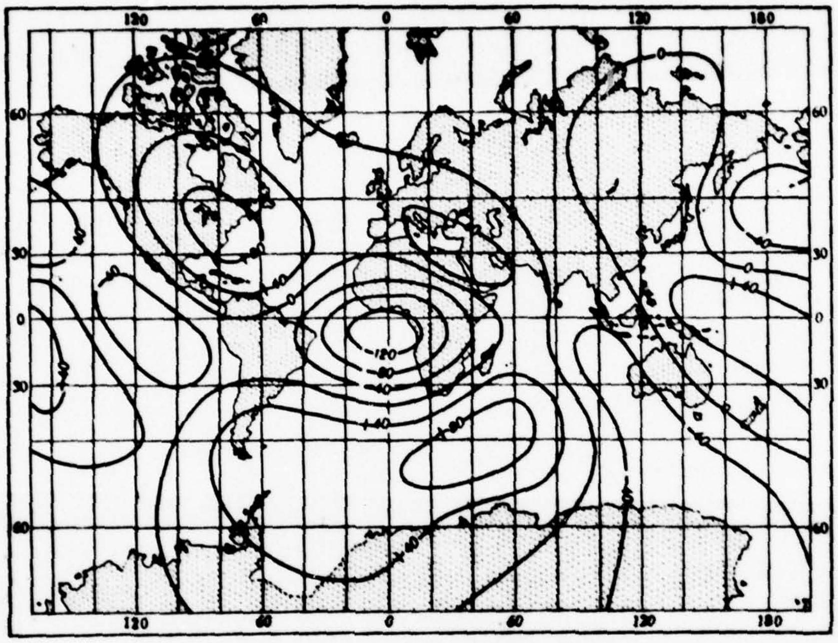

Fig. 18. Field of world magnetic anomalies ΔZ (hundred of gammas) (per Ye. P. Kropachev and V. I. Kolesova, 1967).

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Some researchers (Girdler, 1966) try to explain all differences in the properties of upper mantle pointed out above by the character of the convection currents. So, in regions with positive gravity anomalies and the lowered/reduced heat fluxes is assumed the existence of the descending (omitting) convection currents in mantle. Hence

and the large depth of focus of earthquakes. Regions with the negative gravimetric anomalies, increased by heat fluxes and shallow-focus earthquakes are joined with the ascending convection currents of the substance of mantle.

However, is possible another explanaticn of these differences. Specifically, the different intensity of the process of the differentiation of the substance of upper mantle in the western and east parts of the Indian sector of south ocean, in Western and east antarctica can to satisfactorily explain the observed special feature/peculiarities in the distribution of the physical fields of the Earth. The process of zone melting, possibly, is one of the basic in the mechanism of the differentiation of the substance of upper mantle (Vinogradov, 1966; Belousov, 1968).

end section.

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Chapter IV.

THE THICKNESS AND SOME LINES OF THE STRUCTURE OF THE EARTH'S CRUST IN THE SOUTH OCEAN AND THE CIRCUMLITTORAL ZONE OF ANTARCTICA.

Methods of the study of power/thickness and structure of the earth's crust in the antarctic.

It is possible to consider at present as established the fact that the thickness of the Earth's crust varies from 5 to 70 km and it is divided into two basic types - continental and oceanic. These types of crust sharply are distinguished by structure and history of development. For the continental type of the earth's crust, are characteristic its high thickness (from 30 to 70), three-layered composition (precipitation, the "granite" and

"basalt" complexes), large variability of the relationship/ratios of the thicknesses of layers and entire thickness of crust. The oceanic type of crust differs from the continental in the fact that it has smaller thickness (from 5 to 15 km), is completely excess "granite" layer and consists, besides precipitation and the metamorphized and volcanogenic rock/species of low power/thickness (the so-called second oceanic or supra-basaltic layer), only of one layer, according to the geophysical indices of close to "basalt".

Under the earth's crust lie/rests the shell or the mantle of the Earth which is divided into two layers - upper and lower mantle.

Thickness of the Earth's crust, as is known, it is now determined by the method of deep seismic sounding (GSZ), on the basis of data of seismology or by the indirect methods, based on the empirical relationship/ratios between the thickness of crust and the relief of its upper boundary or between the thickness of crust and the anomalies of the force of gravity in the reduction of Bouguer.

The general idea of the thickness of the Earth's crust of antarctica gives the analysis of the dispersion of channel waves P_g and L_g.

The analysis there of the earthquakes, which intersect continent in different directions, makes it possible to make the conclusion that for antarctica is characteristic of continental type crust, and for the which surrounds continent ocean - an oceanic crust.

Deep seismic sounding in antarctica was not conducted; therefore judgment about the structure of the earth's crust of continent remains to be make only on the basis of indirect methods. To the same is related the approximate computation of the thickness of crust according to Bouguer's anomalies. The recalculation of mean anomalies into the depths of Moho surface can be carried out under some assumptions about the average densities of crust and mantle. However, difference in the real density of crust and mantle from the taken average densities, the deviation of some units of the earth's crust from position of equilibrium and other factors decrease to a considerable extent the accuracy of obtaining depths of up to Mohorovicic's boundary. With the other method of the indirect determination of

thicknesses of the Earth's crust, are utilized their representations in relief.

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Both methods are based on the statistical relationship/ratios, obtained for the thicknesses of crust, on one hand, and the anomalies of Bouguer or heights of external relief - on the other hand. For antarctica in view of the absence of the determinations of the thicknesses of crust by method of GSZ these relationship/ratios it is necessary to extrapolate from other regions. Such relationship/ratios for antarctica were obtained by G. Woollard, A. I. Frolov et al. The results, obtained from these formulas, give approximately identical values. The error in determination of the thickness of the Earth's crust of antarctica and adjacent to it part of ocean was evaluated at $\pm$ 3 — 5 km (systems, etc., 1967). For the south ocean of such relationship/ratios, until now, it was not constructed.

By the at present international union of geodesy and geophysicists is prepared for press/printing the map/chart of the relief of Moho surface. during the utilization of

gravimetric data and relief, is recommended the following procedure of the determination of the depths of Moho surface (JUGG, 1967).

The depth of the Moho boundary from gravimetric data is determined from the statistical dependence between Mohorovicic's depth (H) and the average values of Bouguer's anomalies ($\overline{\Delta g}_B$). Radius of the averaging of anomalies R = 100 km. This dependence linear is expressed by the formula:

$$H = A - \frac{\overline{\Delta g}_B}{KB} \pm C, \qquad (1)$$

where A - depth of Moho surface with $\overline{\Delta g} = 0$;

B - the coefficient, which indicates rate of change of the anomalies in points x and y (or rate of change of Moho surface); in other words - this the horizontal gradient of the force of gravity which is determined experimentally for regions where there is anomaly of the force of gravity and depth of Moho surface by the formula:

$$B = \frac{\overline{\Delta g}_B(x) - \overline{\Delta g}_B(y)}{H(x) - H(y)}; \qquad (2)$$

K is the coefficient, which characterizes the type of the earth's crust (continental, oceanic, intermediate); C is an error in determination of the depth of Moho surface; it

also is determined experimentally for regicns where there is anomaly of the force of gravity and depth of Moho surface.

For values $\overline{\Delta g}_{B}$ within limits ±200 mgal and respectively for the depths of Moho surface from 20 to 60 km of constant value are determined the following: A = 33; K = 1; B = 10; C = ±10 km and formula (1) takes the form:

$$H = 33 - \frac{\overline{\Delta g}_{B}}{10} \pm 10. \qquad (1')$$

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This to formula gives the approximate values of the depth of Moho surface and it is recommended for application/use only for regions where there is no GSZ. For regions where there is data of GSZ, formula (1) is determined experimentally. In these cases for this region, are determined the values of coefficient cf A and the resulting coefficient KB. Error C in these cases is determined also experimentally and, as a rule, lie/rests within limits ±(2-4) km.

For regions where $\overline{\Delta g}_{B}$ are more than ±200 mgal, i.e., for oceanic type crust or for high-mountain regions, a value constant A and B they remain the same as and for a

"normal" continental crust, i.e., A = 33, B = 10, but coefficient K is increased to 2 and more. Formula (1) loses stability and only very roughly characterizes thickness of the Earth's crust.

In those regions where not the gravimetric measurements where were not conducted the seismic soundings and there are no seismological data, for determining the depth of Moho surface it is possible to utilize a dependence between the depth of the surface of the earth's crust and area relief. Specifically, is proposed R. M. Demenitskaya's formula:

$$H = 33\, th(0.38\, \Delta h - 0.18) + 38, \qquad (3)$$

where H is thickness of the earth's crust, km; Δh - height from sea level, km (on dry land has positive value, at sea - negative).

However, formula (3) very approximate, the accuracy of the determination of the depth of the Moho surface or thickness of the Earth's crust in this case is much lower, rather than on the gravimetric and facts it is more according to seismic data. Whole the fact is that dependence (3) assumes the presence of general/universal

isostatic compensation, while real deviation from the condition of equilibrium can be very considerable. So, for island arcs and abyssal trenches are characteristic intense positive and negative (more than ±100 mgal) isostatic anomalies (Gaynanov, etc., 1969), which in recalculation for the earth's crust gives power/thickness 10 km and more.

With the use of the dependence between the depth of Moho surface and the anomalies of the force of gravity, the deviation from isostasy to a certain degree is considered in the averaged anomalies in free air, which are clcse to isostatic.

Dependence between the depth of the Moho surface and the anomalies of the force of gravity and some special feature/peculiarities of crust and mantle in the south ocean and the antarctic.

Using the available of author gravimetric and seismic materials for the region of south ocean and the limb zone of antarctica being investigated are constructed the dependences of the depth of Moho surface (H, km) on

averaged anomalies of the force of gravity in the reduction of Bouguer ($\overline{\Delta g}_Б$). Averaging is carried out on squares 167 x 167 km. Results are represented in Fig. 19.

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In the range of anomalies $\pm$100 mgal, there is eight points with the depth of Moho surface, obtained from industrial and atomic explosions (Africa, Australia, New Zealand) and from data of deep seismic sounding (Strait of Magellan, Lord Howe Rise in the Fiji Sea). The obtained for them dependence linear is expressed by the formula:

$$H = 31{,}5 - 0{,}09\,\overline{\Delta g}_Б. \quad (4)$$

This formula agrees closely with formula (1). The mean square deviation in determining the depth of the Mokhorovichich surface from formula (1) from a comparison with the eight actual points indicated above turned out to be equal to $\pm$2.8 km. Consequently, formula (1) can be employed with confidence for the coastal zone of Antarctica and the outskirts of the continents in the Southern Ocean.

For crusts of the oceanic type, according to data of GSZ (31 points) conducted on water areas of the Atlantic, Indian, and Pacific sections of the Southern Ocean the following relation is

obtained:

$$H = 32 - 0{,}057\,\overline{\Delta g}_{B}. \qquad (5)$$

This formula will agree well with the dependences, brought out by other previously authors and by us and taken for the calculation of power of crust (Gladun, etc., 1963, 1964; Grushinskiy, 1961; Stroyev, etc., 1967; Frolov, 1965 and others).

However, dependence for oceanic crust (5) will not agree with formula (4) for a continental crust in the region of transition from one type of crust to another, in other words in the range of anomalies from +150 to +250 mgal. This and it is logical, since in transition zones the earth's crust has complex structure, here are observed considerable deviations from isostasy.

Research on seismic cut/sections in transition zones it showed that sharp thickening of crust correspond of sufficient to narrow zone continental slope and partly shelf. In the region of continental crust, appears "granite" layer. Because of thickening "granite" and "basalt" layers occurs an increase in the thickness of crust on continent. The earth's crust of transition zones is presented by the series of units with the different depths of the boundaries of consolidated crust, Conrad and Mohorovicic and different physical properties (rate, densities) on these boundaries. Transition from one unit to the next is accompanied by an abrupt change in the cut/section of the earth's crust. In connection with the block-like nature of crust scarcely whether it is possible to assume that the Moho surface during transition from ocean to continent remains "continuous" and simply it is immersed under continent. The boundaries of units pass along faults. The presence of ice load on antarctic continent and its repeated change even more contributed to the breaking up of the earth's crust in the circumlittoral zone of antarctic platform. This same thing is attested to by considerable isostatic anomalies in the limb zone of Antarctica (systems, Frolov, 1969).

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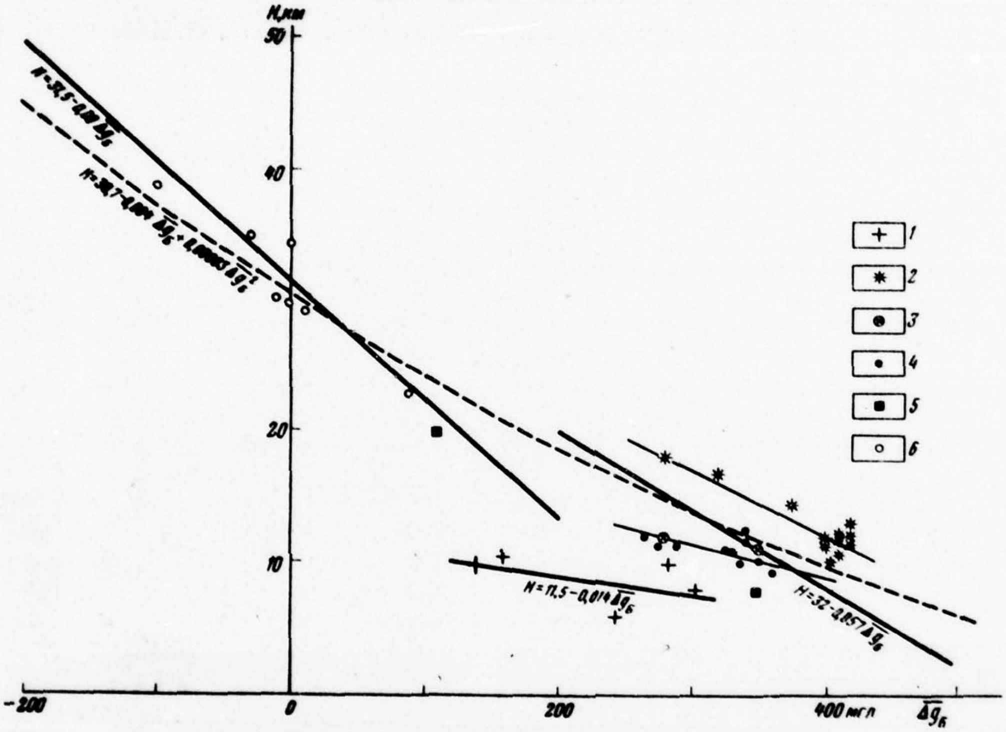

Fig. 19. Dependence between depth of Moho surface and Bouguer's anomalies for south ocean and antarctic. Compiled by P. A. Stroyev 1 - rift zones of Indian Ocean; 2 - the Atlantic sector of south ocean; 3 - Scotia Sea and Drake Passage; 4 - the Indian sector of south ocean; 5 - the Pacific Ocean sector of south ocean; 6 - land (Africa, Australia, New Zealand, south America).

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Break of regression lines in Fig. 19 at the values of Bouguer's anomalies $\approx$ +200 mgal reaches in the thickness of the Earth's crust of value of approximately 7 km. In order to avoid this during the construction of the map/chart of Mohorovicic's isodepths according to gravimetric data, I determined dependence with quadratic member according to all data (eliminating the case of rift zones). As a result is obtained the formula:

$$H=30,7-0,064\ \overline{\Delta g}_{Б}+0,00003\ \overline{\Delta g}^{2}_{Б}. \qquad (6)$$

Putting to use this formula, we determined the depth of Moho surface in the range of anomalies from +100 to +250 mgal.

As is known, on the dispersion of points relative to regression lines it is possible to evaluate the error in determination of the depth of Moho surface from the formulas pointed out above. For formula (4) we have $\varepsilon_{H}=\pm1{,}2$ km, for formula (5) $\varepsilon_{H}=\pm2{,}6$ km. Estimation, carried out on several control points, gave error $\varepsilon_{H}=\pm2{,}5$ km. Thus, putting to use formulas (4), (5), (6), we we obtain the depth of Moho surface according to gravimetric data with the root-mean-square error $\varepsilon_{H}=\pm2\div3$ km.

Analyzing Fig. 19, one should focus attention on such special feature/peculiarities. First of all this relationship/ratio between thickness of the Earth's crust and the anomalies of the force of gravity for rift zones of Indian Ocean. It is expressed by the formula:

$$H = 11{,}5 - 0{,}014\Delta g_{Б}. \quad (7)$$

This dependence differs significantly from all other communication/connections. This indicates to completely different, the peculiar type of the earth's crust, sharply different from the crust of oceanic and continental types.

Further one should focus attention on the points, pertaining to Atlantic Ocean. This is almost continuous profile of GSZ, carried out in Argentine basin from the Mid-Atlantic spine/ridge to the continental slope of south America. For the comparison it is selected of 12 points, sufficiently far apart (100 km and more than). As is evident in Fig. 19, these points are separate/liberated into the group, which lies aside from the points of Indian and Pacific Oceans. This fact characterizes the regional special feature/peculiarities of the structure of the earth's crust and upper mantle under the bottom of Atlantic Ocean. Earlier by us (Stroyev, Gaynanov, 1965) were comprised the

graph/diagrams of the dependence of anomalies in free air and Bouguer on the depths of the bottom of Indian, Pacific and Atlantic Oceans. For one and the same intervals of depths, the scatter of the anomalies of the gravitational force for Atlantic Ocean proved to be more than for calm and Indian.

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It is possible, these differences are caused by the larger heterogeneity of the substance of the earth's crust and upper mantle in the region of Atlantic Ocean in comparison with Pacific and Indian Oceans. Variations in the rates of longitudinal seismic waves on the Moho surface in Atlantic and Pacific Oceans (Gurariy, Solovyev, 1963) show that, probably the upper layers of mantle are less uniform in density near Atlantic Ocean, rather than under Pacific.

Finally, let us note that two points of seismic-refraction sounding at Scotia Sea and at Drake Passage (for which there are the corresponding values of the anomalies of the force of gravity) they lie/rest at the group of the points of the Pacific and Indian Oceans and far are located from the group of the points of

Atlantic Ocean. Although the statistician and insufficient, one ought not to count that Scotia Sea and Drake Passage are characterized by the special structure of the earth's crust and upper mantle, rather than other deep-water basins of Atlantic Ocean?

Power/thickness and some lines of the structure of the earth's crust in a south ocean.

On the basis of the map/chart of Bouguer's averaged anomalies by formulas (4) - (7) were calculated the depths of the bottom of the earth's crust. The accuracy of the determination of Mohorovicic's boundary is estimated 2-3 km; therefore the lines of the equal values of its depths we have carried out through 5 km. The map/chart of the depths of Moho surface is represented in Fig. 20, 21 and 22. Unlike prviously published maps, this map/chart is constructed not on the basis of the probabilistic dependence, constructed according to the formula of plane-parallel layer with the predicted difference in the densities $\Delta\sigma$ = 0.4-0.5 g/cm³ and conditionally taken absolute term H = 33 km, but on the basis of actual

data. Consequently, the authenticity of this map/chart is considerably above, and map/chart reflects the real special feature/peculiarities of the thickness of the earth's crust. The analysis of this map/chart in conjunction with seismic data makes it possible to note the following basic features of the structure of the earth's crust of south ocean.

The Argentine basin has fine/thin crust as thickness into 5-10 km and its typically oceanic structure. The seismic investigations in profiles by extent in several thousands of kilometers revealed the here horizontally lying/horizontal upsets by power/thickness to 2.5 km which will lie on the typical basement ("basalt" layer) of oceanic crust. The thickness of "basalt" layer is 4-5 km. The roof of this layer forms corrugated relief with amplitude to 0.5 km. The depth of Moho surface is about 10-15 km. This structure of the earth's crust is outlined from the Mid-Atlantic spine/ridge to the foot of the continent of south America. One should note also that the power/thickness of precipitation in the Atlantic sector of south ocean is much greater than in other sectors. Of the foot of continental slope, the power/thickness of precipitation grow/rises to 6 km, the thickness of "basalt" layer is increased to 10-12 km.

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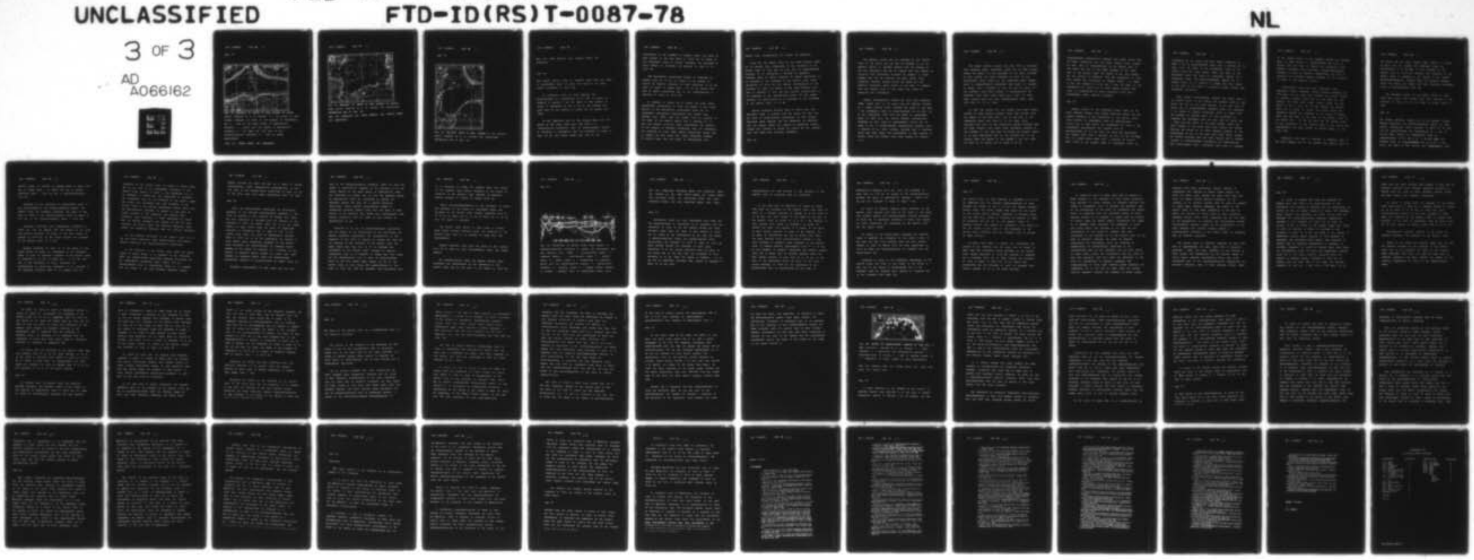

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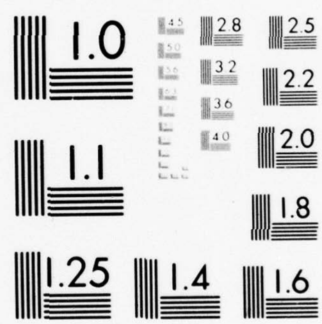

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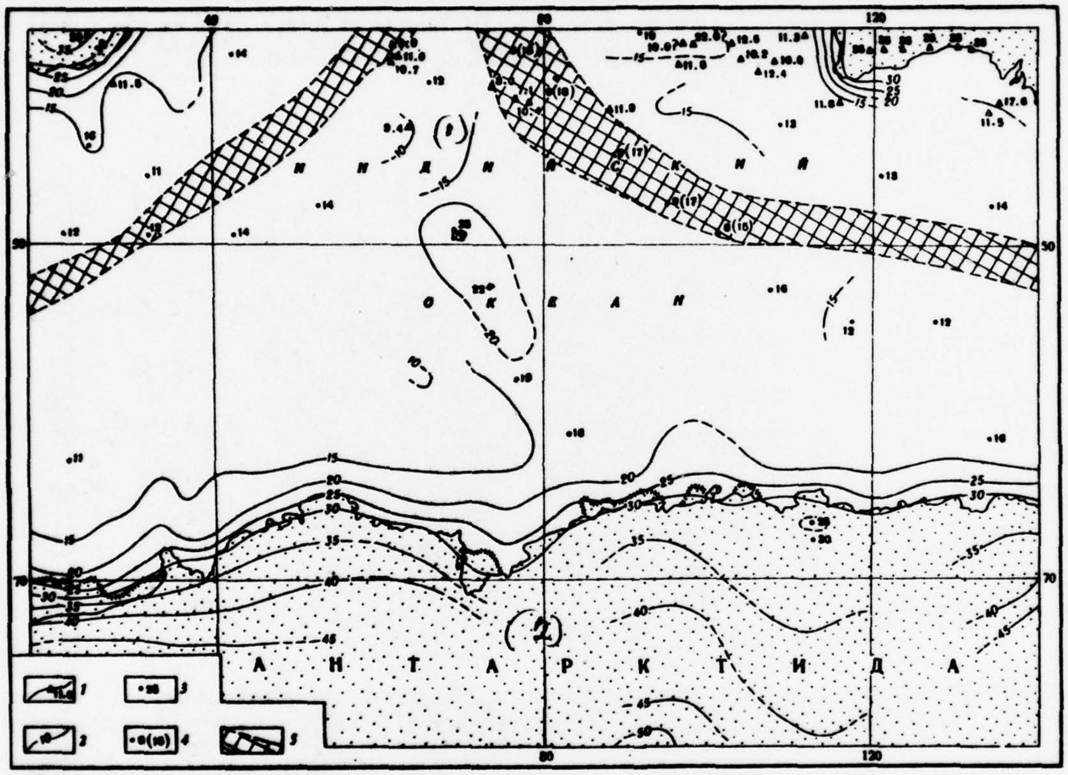

Fig. 20. Map/chart of depths of Moho surface of Indian sector. Compiled by P. A. Stroyev. 1 - the points of deep seismic soundings and depth of the boundary of Mohorovicic, km; 2 - line of the equal depths of Mohorovicic's boundary; 3 - points with the depths of Mohorovicic's boundary; 4 - the same, for rift zone of the Australo-Antarctic elevation; 5 - zone of median spine/ridges.

Key: (1). Indian Ocean. (2). Antarctica.

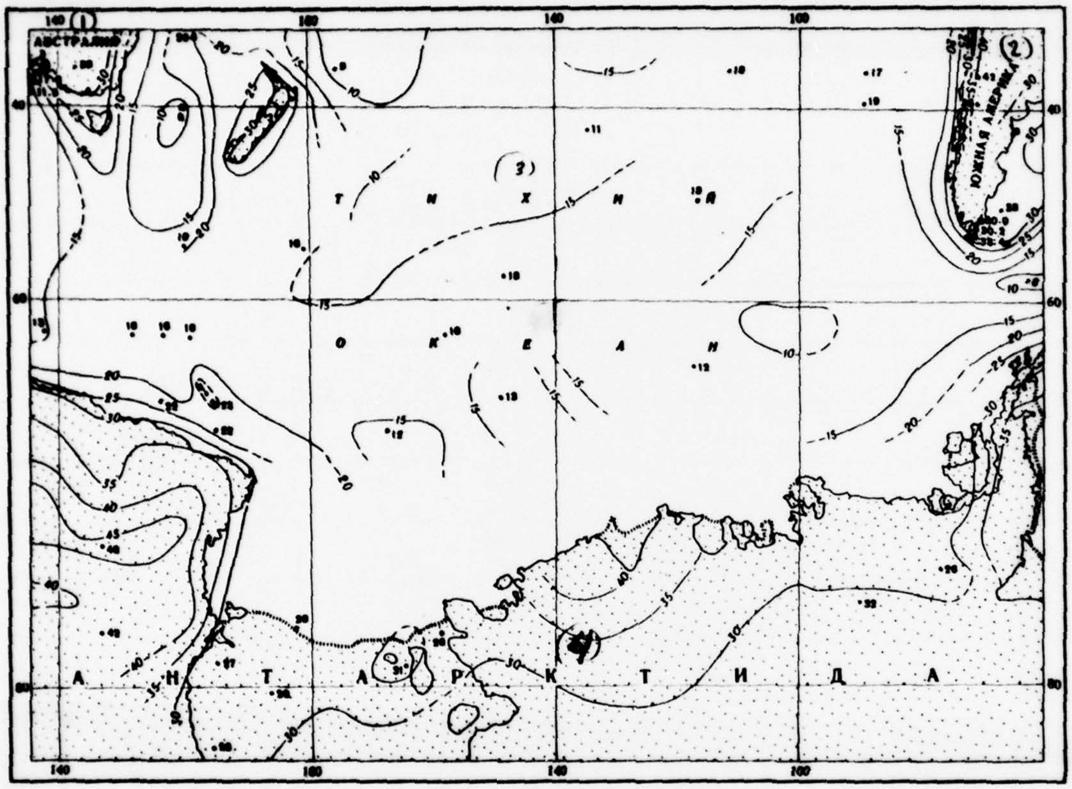

Fig. 21. Map/chart of depths of Moho surface of Pacific Ocean sector. Compiled by P. A. Stroyev. The conventional designations see in Fig. 20.

Key: (1). Australia. (2). South America. (3). Pacific Ocean. (4). Antarctica.

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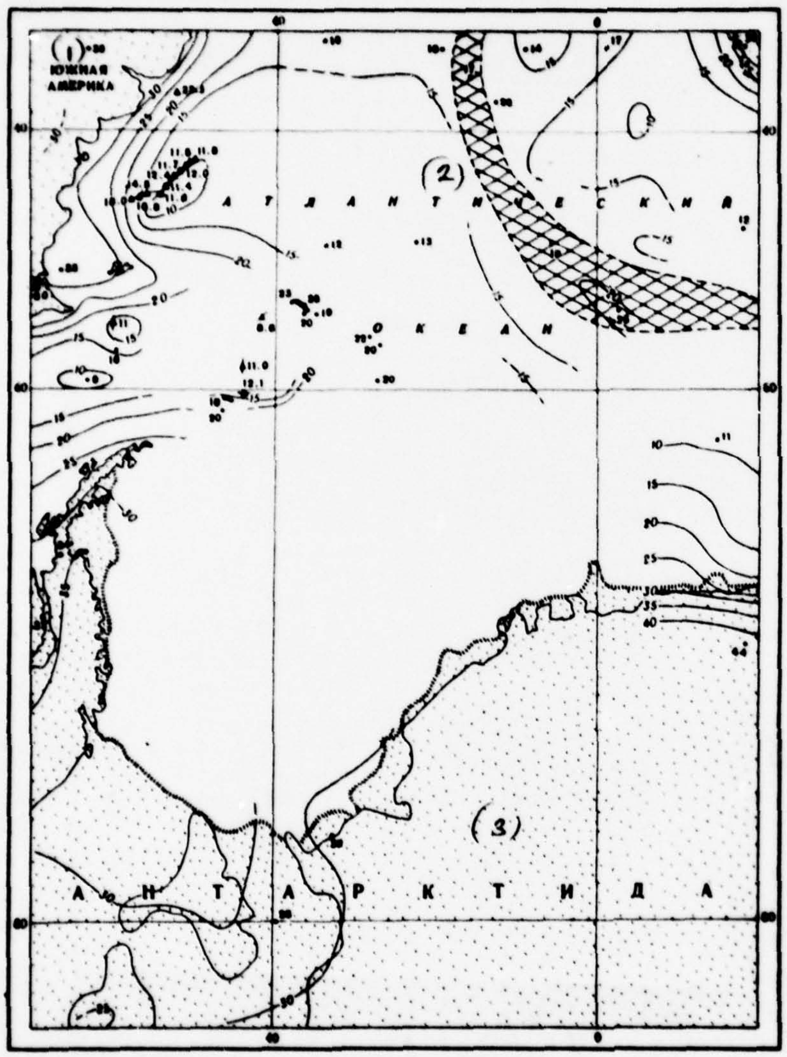

Fig. 22. Map/chart depth of Moho surface of the Atlantic vector. Compiled by P. A. Stroyev. The conventional designations see in Fig. 20.

Key: (1). South America. (2). Atlantic Ocean. (3). Antarctica.

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Here appear typical rocks of "granite" layer with the speed of longitudinal waves 5.8 km/s. The depth of the Moho surface grow/rises to 20-25 km.

In continental shelf of south America, the power/thickness of precipitation is 6-7 km. In Strait of Magellan it reaches 9 km. The depth of Moho surface in Strait is determined 30 and 35 km of the northern and south ends of the profile by length 200 km (Ludwig a.o. 1965).

In the deep-water part of the Agulhas Basin with the depths of the ocean floor more than 5000 m is reveal/detected sedimentary layer by power/thickness 300-600 m. According to gravimetric data the thickness of crust is here 4-6 km. One should assume that this of the

rock/species of the basement of oceanic crust. The depth of Moho surface in the Cape Basin is 10-12 km. In region of the continental slope of African continent, the thickness of crust sharply is increased, and narrower in coast it is 30-35 km.

The Mid-Atlantic spine/ridge clearly is contoured by isomoho lines of 15 km. In region of the islands of Tristan da Cunhathe thickness of crust grow/rises to 20 km, while in region of Bouvet Oeya - to 25 km. Narrow rift zone of median spine/ridge has, on our interpretation, a thickness of crust to 13-15 km.

M. Talwani, J. Heezen and M. Worzel are given three hypothetical cut/sections of crust and mantle in the center section of the Mid-Atlantic spine/ridge, which can be visualized, interpreting gravitational and seismic data (Talwani a.o., 1965). They all proceed from the presence of the layer of low density mantle with a velocity of 7.5 km/s and density 3.15-3.20 g/cm³. Nevertheless the analysis of the complex of different geophysical data for determining the structure of crust under median spine/ridges showed that in general the data agree well among themselves. However, in certain cases they are found in contradiction that

impedes their interpretation and raises its ambiguity.

Since for the median ridge of the south Atlantic there are no seismic data, explanation of the structure of the earth's crust of this part of rift zone is hinder/hampered. Therefore we is interpreted a decrease in Bouguer's anomalies under an entire structure of median spine/ridge by an increase in the thickness of the Earth's crust under spine/ridge to 18-20 km. The further investigations of the structure of crust and mantle in the south Atlantic will make it possible to give the more precise interpretation of the anomalies of the gravitational force. The Rio Grande elevation is characterized by an increase in the thickness of the Earth's crust to 19 km.

Special attention deserves area of Scotia Sea. This deep-water basin is limited from the north, the east and the south of South-Antilles spine/ridge. In west through deep-water Drake Passage, the sea depression is connected with the Pacific Ocean. The complex of underwater ridges, islands and trenches is called the Scotia Arc and connects ierra del Fuego with antarctic peninsula.

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The geologic nature and the structure of the earth's crust of the Scotia Arc and Sea is attested to by two opposite points. D. Matthews asserts that the islands of arc are continental and sea is located into the process of evolution from continental structure to oceanic. D. Hakes assumes that the arc presents the split (torn) cross connection (bridge) between Tierra del Fuego and the antarctic peninsula, which drifts to the east. It assumes that the oceanic crust of the Scotia Sea slowly is converted into continental.

Seismic investigations carried out into 1959 (Woollard, 1960), showed that to the south from the Falkland Islands is a normal oceanic crust, although the depth of sea here 3 km. Sedimentary layer by power/thickness 0.5 km will lie on the crystalline rocks with the speed of longitudinal waves 6.3 km/s (i.e. the typical "basalt" rock/species). Thickness of this layer of approximately 7.0-7.5 km. At depth 11 km, is reveal/detected Mohorovicic's boundary with a velocity of 8.3 km/s. However, narrower then G. Woollard noted that this region was such/similar tc many regions of Pacific Ocean and differs from other regions of Atlantic Ocean.

The second profile, carried out into 1959 is stretched from Argentine basin, intersects island arc of South Georgia Island and departs to the southeast to 57° south latitude. On this profile the total thickness of crust is not investigated. Under island arc and especially under abyssal basin is reveal/detected continental type crust. It consists of layers with a velocity of 2.0; 4.0 and 5.6 km/s. To the southeast from South Georgia is reveal/detected the laminated crust whose lower layer has a rate 7.6 km/s. Upper crystal layer has also lowered/reduced rates, which vary from 5.7 to 6.3 km/s.

In 1962 was carried out the profile from South Orkney Islands to South Georgia Islands. Along this profile with the depths of sea more than 2 km of the rate of the crystalline rocks vary from 5.7 to 6.2 km/s, which coincides with data of the cut/section between Birdwood Bank and South Georgia. This speed range indicates, probably to the presence in the east part of Scotia Sea granite layer. It is very interesting that at the northern end of the profile where the depths of sea compose 3 km, the rates in crust it is above, and at depth 8 km is

reveal/detected Mohorovicic's boundary with normal mantle rate 8.0 km/s. Cut/section has the normal oceanic crust, similar as that, that is reveal/detected in the western part of the Scotia Sea and in the Drake Passage. In the south part of the profile where the depths of sea also exceed 3 km, the picture is different. Here the cut/section of crust more reminds the cut/section of abyssal trench - at depth 11 km, the boundary of crust has a rate 7.6 km/s. At the intersection of island arc of South Orkney Islands, the crust is characterized by block structure; units have abrupt/steep, almost vertical contacts.

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Seismic profile in the Bransfield Strait south of the South Shetland Islands also showed block-like nature and the complex tectonics of the cut/section of the earth's crust. Crust consists of sedimentary layer by power/thickness 1.5-2.5 km, in some places are encountered the lens of the consolidated precipitation and volcanic rock by power/thickness to 3-5 km. Will lie below the metamorphic and igneous rocks with a velocity of 4.5; 5.0 and 5.5 km/s. Even is located below layer with a velocity of 5.9-6.0 km/s, close to the granite layer of continental crust. On

cut/section to the south from King George (Waterloo) at depth 5 km is reveal/detected layer with a velocity of 7.1 km/s, i.e., the layer of the intermediate rocks of the earth's crust and upper mantle. Thus, the crust of the Bransfield Strait has layers at velocities, typical for a continental crust, and power/thicknesses, typical for an oceanic crust. It is possible to assume that this region is the part of the zone of transition between oceanic and continental structures.

Thus, seismic investigations revealed the normal type of the earth's crust in the western and northern parts of the Scotia Sea and in the Drake Passage. In the east part of Scotia Sea is reveal/detected laminated crust with unusually a low series of seismic velocities, which is joined with the presence of granite layer. On this basis/base is presented the hypothesis that the east part of Scotia Sea - these are the relict of the more ancient island arc, which existed to the south from South Georgia and western existing now active arc of South Sandwich Islands. On the spine/ridges of arc to the east from South Orkney Islands and between Birdwood Bank and South Georgia and in abyssal trenches is reveal/detected continental and subcontinental type three-layered crust. Continental type crust is revealed

on the igneous Earth, on the Falkland islands and Birdwood Bank. In some regions is reveal/detected the crust of mongrel with the signs of oceanic and continental crust. Numerous intrusion, block tectonics, reveal/detect/exposed according to data of magnetic observations, all this it indicates the extremely complex character of the structure of crust in the indicated region.

Gravitational field even more underscores this complexity. Faye's extremely intense positive anomalies (to +150 mgal) and at point time "normal" for oceanic trench of Bouguer's anomaly (from +350 to +400 mgal) are one sides;on the other hand, normal oceanic crust, but the depths of sea a total of 2-3 km! Unusual for Atlantic Ocean and is closer to Pacific and Indian Oceans the dependence between the anomalies of the force of gravity force and the depth of the base of the earth's crust at the Scotia Sea - on the one hand and the unusual rates of the cut/section of the earth's crust of the Scotia Sea, characteristic for many regions of Pacific Ocean, on the other hand.

Gravimetric data make it possible to establish that in the Drake Passage and in the central and northern parts of

the Scotia Sea the crust oceanic, Moho surface is located on depth 9-15 km. Islands and underwater ridges are characterized by an increase in the thickness of the Earth's crust to 20-25 km, moreover this thickness of the Earth's crust is inherent in all islands of arc without exception/elimination. Birdwood Bank, the Falkland Islands, Tierra del Fuego, and Graham Land have typically continental crust as power/thickness 25-30 km.

The deep-water basins of the Indian sector of south ocean have normal type oceanic crust both according to the thickness of layers and on the rates of seismic waves in them.

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The seismic profiles, carried out in the Agulhas, Crozet, Western Australian and Southern-Australian Basins, it gave similar cut/sections. Under thickness of water 4-5 km will lie low power/thickness the precipitation at a rate of 2.5-3.5 km/s. Further go "superbasalt" layer by power/thickness 1.5-2.0 km ((v_r = 5.0-6.2 km/s) and "basalt" layer by power/thickness 3-5 km ((v_r = 6.8 km/s). The depth of Moho surface with normal-mantle rates

(8.0-8.2 km/s) is recorded in Agulhas Basin at depth 11.5 km, in Crozet Basin - at depth 9-11 km, in Western Australian basin - 10-12 km and in Southern-Australian - 11.5 km.

According to the character of gravitational field in the African-Antarctic and Australo-Antarctic basins, the earth's crust has analogous structure. The depth of the base of crust in the African-antarctic basin is equal to 8-11 km, in the Australo-Antarctic basin - 12-15 km.

Underwater elevations have considerable thickening of crust. So, near the Agulhas Bank and Plateau to the south from African continent the depth of the Moho surface is omitted on 16-18 km; on the Crozet Plateau the thickness of the Earth's crust is 14 km.

Maximum thickening of crust is in the center of the Indian sector of ocean. It corresponds to the Kerguelen Ridge. On Iles de Kerguelen thickness of the Earth's crust is increased to 25 km, on Heard Is. - to 22 km. The zone of the thickening of crust, following the configurations of spine/ridge Kerguelen, it is stretched in the southeast direction where it is clamped with the

projection of the earth's crust in region of Pravda Coast and in the form of the considerable thickening of the earth's crust departs to south to the Gamburtsev Mts. It is necessary to assume that the spine/ridge of Kerguelen has continental type of the structure of the earth's crust. One should also set/assume that this structure of the earth's crust is the ancient mountainous region, which cuts the East-Antarctic platform. On surface it will bear on itself circuits of the Gamburtsev and Golitsyn Mts., underwater ridge Kerguelen. If these reasonings are valid, then on Princess Elizabeth Land between 80 and 90° east longitude one should expect the under-ice mountains, which connect the Gamburtsev Mountains with the Golitsyn Mountains.

By the greatest thickening of the earth's crust (to 15 km) are noted underwater ridge Western-Indian, East-Indian, Western Australian and Australo-Antarctic uplift/rise.

On the structure of the earth's crust under the median ridges of Indian Ocean, it is possible to say following. Under the Arabian-Indian spine/ridge American researchers did not reveal/detect anomalously upper mantle with the lowered/reduced rates of longitudinal waves. It is possible, this the result of the used procedure (distance between

seismic stations was about 300 km). As a result of seismic investigations, Soviet geophysicists reveal/detected in the rift zone of the Arabian-Indian spine/ridge at depth 7.5 km of sea level layer with speed longitudinal there 7.0 km/s.

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Under the Western-Indian spine/ridge the satisfactory agreement of the observed lowered/reduced anomalies of the force of gravity in the reduction of Bouguer with those who were calculated is possible with two versions of the structure of crust and mantle (Fig. 23): 1) at the normal density of upper mantle under the ridge cf spine/ridge according to gravimetric data it must be root in the earth's crust where the depth of Mohorovicic's boundary sinks to 12-14 km; 2) at the anomalously low density of upper mantle under spine/ridge thickness of the Earth's crust decreases. The power/thickness of ancmalous mantle depends on the degree of thinning. If a decrease in the density in anomalous mantle reaches 0.2 g/cm³, then lower boundary of anomalous mantle under the Western-Indian spine/ridge, probably is arrange/located at depths 18-20 km.

Analogous interpretation we have given also for rift

zone of the Australo-Antarctic elevation. There you gave the depths of Mohorovicic's boundary in two versions: a) at the normal density of the upper mantle of Mohorovicic's depth are calculated by formula (6); b) with the anomalous mantle of Mohorovicic's depth are calculated by formula (7). Ambiguous results are also for a Western Australian spine/ridge. Soviet seismic investigations showed on spine/ridge typically oceanic crust with the depth of Moho surface 10 km. American work showed here subcontinental type seismic cut/section with the depth of Moho surface of approximately 22 km.

Therefore by us for the Western-Australian spine/ridge and the region of the articulation of the east-Indian and Western Australian spine/ridges the interpretation of the anomalies of the force of gravity is carried out also for two versions of the structure of the earth's crust and upper mantle (see Fig. 23): 1) if is confirmed the cut/section of the earth's crust, obtained by American researchers, then it is possible to assume that this region has the subcontinental type of crust as power/thickness 18-22 km and with normal upper mantle; 2) but if the earth's crust in this region has power/thickness on the order of 10-12 km, then for agreement with gravimetric data

it is necessary to assume the presence under this region of the unpacked upper mantle. Depending on the degree of reduction of the density, lower boundary of anomalous mantle, probably is located on depths 26-34 km.

During approach/approximation to the continents of Africa and Australia in the region of continental slope, the thickness of the Earth's crust sharply grow/rises from 15 to 30 km of shore and to 35 km of shore and to 35 km into the depth of continent.

The Pacific Ocean sector of south ocean in seismic sense barely studied. Therefore about the structure of the earth's crust, here it is possible to speak only very approximately.

Oceanic fine/thin crust with the depth of Moho surface 8-12 km is noted in deep Bellingshausen, South, and Tasman Basins.

The southern-Pacific Ocean and Eastern Pacific Ocean elevations are characterized by the thickening of the earth's crust and by the depth of its bottom to 18-20 km.

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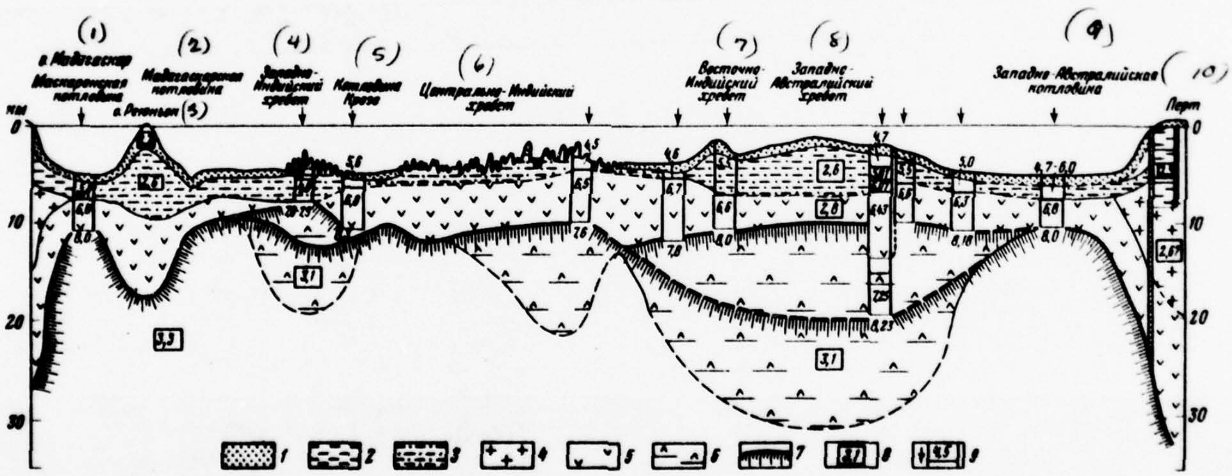

Fig. 23. Cut/section of earth's crust along profile o. Madagascar-Australia according to seismic and gravimetric data (per Gainanov, etc., 1969) 1 - unconsolidated upsets; 2 - condensed upsets; 3 - supra-basaltic layer; 4 - granite layer; 5 - basalt layer; 6 - rock/species of anomalous mantle with the lowered/reduced density; 7 - Mohorovicic's boundary; 8 - density, g/cm²; 9 - seismic points; numeral in columns - boundary rates of longitudinal waves, km/s.

Key: (1). Madagascar, Mascarene Basin. (2). Madagascar Basin. (3). Reunion Is. (4). West Indian Ridge. (5). Crozet Basin. (6). Mid-Indian Ridge. (7). East-Indian Ridge. (8). West Australian Ridge. (9). West Australian Basin. (10). Perth.

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New-Zealand island arc with continental type crust and the power/thickness of last/latter 30 km continues with the thickening of crust in the New Zealand Plateau and under Macquarie Ridge where the depth of Moho surface is 19-20 km. In region of the intersection of arc with the median of Australo-Antarctic Ridges and Southern-Pacific Ocean uplift/rises, the thickness of crust is equal to 16-18 km. Under Balleny Islands the thickness of crust again grow/rises to 23 km. During transition from the basin of the Tasman Sea to the Mill Rise the thickness of crust increases to 20 km, under the island of Tasmania - to 25 km, and on Australian continent Moho surface is immersed at depth 30 km and more.

Power/thickness and some features of the structure of the earth's crust in transition zone of antarctica.

In the limb zone of antarctica in region of Queen Maud Land the thickness of the Earth's crust from south to north at a distance 800-1000 km changes on 34 km (from 10 to 44 km). The total change of the depth of the base of the earth's crust in region is 36 m on 1 km. However, on some sections this change is different. In region of Lazarev Ice Shelf the gradient of a change in the depth of Moho surface composes 36 m/km, of Roi Baudouin Sta. - 65 m/km, in Luetzow-Holm Bay and on Prince Olav Coast - 140 m/km, moreover from intracontinental plateau to the outer boundary of mountain range thickness of the Earth's crust is changed smoothly approximately from 44 to 35 km. On the boundary of mountain ridge/range and foothill glacier plain and in shelf zone on Princess Ragnhild Coast the Moho surface sharply is risen from 36 to 24 km. In the zone of the continental shelf the depth of the crust trough decreases to 17-18 km. The depression of the Riiser-Larsen Sea, is characterized by the depth of

Mohorovicic's boundary 10-14 km, i.e., the thickness of crust here is 7-10 km. In region of the African-Antarctic platform the depth of Mohorovicic's boundary - about 8-10 km, and the thickness of crust is about 5 km.

In region of Wohlthat mountain mass, thickness of the Earth's crust composes more than 40 km, while in the shelf zone between Lazarev and Novolazarevskaya Stations decreases to 30-28 km. To underwater elevation to north from Lazarev Ice Shelf corresponds the thickening of the earth's crust and its smooth change.

In region of the Riiser-Larsen Peninsula and Gunnerus Ridge is observed the thickening of the earth's crust. To the east and west from Gunnerus Ridge the Moho surface steeply is risen of depths 24-25 km under spine/ridge to 15-17 km under the basin/depressions of Cosmonaut Sea and Riiser-Larsen Sea.

Attention is drawn to two meridional thickenings of the earth's crust, not noted in the relief of the bottom of sea: one in the center of Riiser-Larsen Sea to the northeast from Roi Baudouin Sta., another at Cosmonaut Sea to the northeast from Showa Sta.

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The earth's crust on these sections is thickened on 4-5 km in comparison with the adjacent basin/depressions of seas, although the depths of sea in no way are changed (Stroyev, Frolov, 1969). One should assume that these are the roots of the ancient buried folding, analogous to Gunnerus Ridge and the Maud Rise, which is stretched in parallel to these by structures and cut off by the repeated onsets of mainland glacier. The absence of increases in the relief of the sea bottom in the place of the thickening of the earth's crust testifies from the isostatic lack of balance of these sections.

On Prince Olav Coast to coastal line corresponds the isoline 30 km. Northern than the shore line in region of shelf zone and continental slope thickness of the Earth's crust sharply decreases to 15-18 km, reaching at Cosmonaut Sea a thickness 10-12 km. At Showa Station the thickness of crust is equal to 30-31 km. To the south from Luetzow-Holm Bay the thickness of crust is increased very slowly, reaching 45 km on 73° south latitude.

In transition zone of Queen Maud Land we observe a sharp decrease in the thickness of crust during transition from continent to ocean. However, on different sections this change is dissimilar, i.e., is observed the different type of the articulation of the units of continental and oceanic crust. In connection with the block-like nature of crust scarcely whether it is possible to assume that the surface of oceanic layer and mantle remains "continuous" and simply it is immersed under continent. The boundaries of units pass along faults. The presence of ice load and the action/effect of the forces of isostasy even more contributed to the breaking up of the earth's crust of the edge of antarctic platform. The zones of relative uplift/rises and depressions, which are stretched in submeridional and sublatitudinal directions in the circumlittoral part of the continent, and are such faults. On these faults occurs the introduction from the depth of more base material, that also finds its reflection in the field of gravitational in magnetic anomalies. The downwarp/trough of crust under mountain masses seemingly had compensated for in the zone of shelf where the intense positive anomalies indicate the presence of excess masses,

displaced from under mountainous regions. However, if compensation was realized on entire region without the faults of crust, after seizing and shelf zone, then here could not appear intense positive anomalies. On the contrary, as in foothill regions, here it would be possible to expect small negative anomalies. The faults of the earth's crust in limb zone, especially in the zone of shelf, are outlined on entire coast of east antarctica (systems, frolov, 1967). They, apparently and are the signs of the manifestation of isostatic and anti-isostatic forces. Glacioisostatic motions, caused by the action/effect of ice load, together with tectonic motions created a block-laminated structure of the earth's crust in transition zone of antarctic continent.

The average value of isostatic anomalies on Queen Maud Land is approximately +20 mgal, while that of Bouguer's anomalies - about +100 mgal. According to the relation of these values, the compensation for the external masses of entire region comprises approximately 80o/o. This value corresponds well to the common/general/total compensation for antarctic continent, equal to 85o/o (Stroyev, Frolov, 1969).

end section.

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In region of Enderby Land with the amplitude of heights more than 1500 m the power/thickness of the terrestrial core changes so smoothly and is insignificant as usually in the low plains sections of coast. The Olderdays, Scott, Raggat, Tula Mountains and others do not have the necessary for full/total/complete isostatic compensation increase in the thickness of crust. So, to north of isoline 30 km, in region of the highest Napier Mts. where it would be possible to expect an increase in the thickness of crust on 10 km, the depth of the surface of Mokhorovich remains almost constant or even somewhat it decreases. The conclusion about absence near mountains of Enderby Land of isostatic compensation is confirmed by isostatic anomalies. In region of Enderby Land, Kemp Coast, and Mac-Robertson Coast are noted the considerable positive (from +40 to +60 mgal) isostatic anomalies which are adapted to mountain masses. Anomalies in free air at Enderby Land are from +100 to +170 mgal, and regional anomalies in free air - from +80 to +100 mgal. To the

south from 68° south latitude both anomaly of Faye and the isostatic anomalies they decrease. Bouguer's anomalies on Enderby Land are close to zero; therefore mountain masses are here distant from isostatic equilibrium.

In region of Pravda Coast the thickness of the Earth's crust from south to north at a distance 650-800 km changes on 32 km (from 50 to 18 km). In this case, from intracontinental plateau to the outer boundary of shelf zone, the thickness of the Earth's crust is changed very smoothly. In the zone of continental slope by width 5-100 km the Moho surface is sharply risen from 30 to 18 km.

Chelyuskintsev Peninsula probably is the result of changing (increase) the thickness of the Earth's crust.

Region of the Bunger and Obruchev oases does not have the expected increase in the thickness of the Earth's crust, but on the contrary, the depth of Moho surface there decreases. This fact, and also the high value of isostatic anomalies (+68 mgal) indicate the absence of the isostatic compensation of region of the Bunger-Obruchev oases.

To shelf low water to north of Shackleton Glacier in region of Pobeda Is. corresponds the thickening of the earth's crust on 4-6 km in comparison with the crust of the basins of the Davis and Mawson Seas the west and the east of this low water. In ocean this projection of the earth's crust changes its northern direction in the northwestern and is connected with the structure of Kerguelin Ridge. On continent it is connected with the thickening of crust which from Pravda Coast in meridional direction is stretched to Gamburtsev Mts.

On Wilkes Land the thickness of the Earth's crust very vary smoothly from 40 km on 76° south latitude to 30 km on the shore of continent with uplift of crust on 2.5-3.0 km in region of Budd Coast. In circumlittoral and shelf zones the thickness of crust is changed from 30 to 25 km and decreases to 20 km on 64° south latitude.

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On Victoria Land the earth's crust has typically mainland character. The greatest values of the depths of the boundary of Mokhorovicic equal to 45-48 km, are noted in region of trans-Antarctic mountains and east plateau.

Wide on intermountain basins on Oates Coast and on George V Coast corresponds a decrease in the thickness of crust on 4-6 km. During junction from continent to Pacific Ocean and Ross Sea, the thickness of the Earth's crust decreases to 25-30 km in the region of shelf and to 16-18 km in the region of continental slope and beginning of basin. A decrease in the depth of Moho surface is noted during junction from antarctica and to Indian Ocean in region of Victoria Land (from 30 km in coast of continent to 20 km in the oceanic region). In region of the Balleny Islands the thickness of crust is equal to 22-24 km.

It should be noted that the junction from antarctic platform to oceans in region of Wilkes Land and Victoria Land occurs sufficiently sharply, Moho surface rapidly is risen, forming abrupt/steep slopes. In this transition zone also one should expect the presence of deep faults, to which testify considerable gravitational gradients in this part of the edge zone of Antarctica.

In the limb zone of Western Antarctica, the greatest submersion depth of the boundary of the earth's crust (40 km) is establish/installed under the mountain ranges of Marie Byrd Land (Executive Committee, Hal Flood, Eisel

Ford), in the center section of the antarctic peninsula (35 km), and also in Jones Mts., also on Luitpold Coast (32 km). The smallest depth (25-28 km) is noted in the innermost sections of basin/depression, that is stretched from Ross Sea to Bellingshausen Sea and further to Weddell Sea. So, under the Filchner Ice Shelf, in the innermost part of the basin/depression of glacier, the depth of Moho surface is 25-26 km, in the more elevated part of the basin/depression of glacier, it grow/rises to 30-31 km. In area of Weddell Sea the thickness of crust is close to 30 km. On the Ross Ice Shelf the depth of the boundary of Mohorovicic is 27-28 km, in region of Roosevelt Highland and on Shirase Coast - to 30-31 km.

Generally one should say that transition zone from antarctic continent to the Pacific Ocean and Atlantic sectors of south ocean in Western antarctica is studied much weaker than a east.

Analyzing the circuit of the structure of the earth's crust in the south ocean and the antarctic, it is possible to see that the isolines of the Moho surface clearly record/fix the basic structural special feature/peculiarities of the structure of the relief of the bottom of ocean and coastal zone of antarctic continent.

coastal zone of antarctic continent.

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The fault of the earth's crust in a circumlittoral part of the antarctic continent.

The results of the analyses of the morphology of the bottom of sea of the circumlittoral part of antarctica showed that in the shelf zone of the sixth continent is a system of abyssal basins, which stretch to hundreds of miles mainly in sublatitudinal, and on some sections and in submeridional directions.

The at present available data still insufficient for final judgment about propagation, character and the nature of this formation. Investigations do not cover completely even the shelf zone of antarctic continent, but many faults of crust, traced in this zone, they depart under shelf and mainland glaciers, and their position under continental ice can be establish/installed only by geophysical methods. A series of the reveal/detect/exposed basin/depressions in

shelf, traced to the edge of shelf glaciers by hydrological measurements, it proved to be possible to connect according to the results of geophysical investigations (systems, frolov, 1967) into single system, after showing their continuation under shelf glaciers an entire periphery of east Antarctica from 20° west longitude to 150° east longitude, i.e., for the extent/elongation more than 8000 km (Fig. 24).

The most in detail antarctic boundary/edge fault of crust is investigated and described on section from the east edge of Shackleton Ice Shelf (105° east longitude) to the western edge (80° east longitude) of West Ice Shelf (Stroyev et al., 1965).

It turned out that in region of West Ice Shelf of Pravda Coast and Shackleton Ice Shelf follows the trench with depths to 1450 m, which is decomposition of the earth's crust on the periphery of continent. This trench has in essence sublatitudinal strike/course; however on some sections it is interrupted by submeridional structures (uplift/rise of the bottom in the center of West Ice Shelf the depression of the Denman Glacier Tongue). To the east from 108° east longitude, the vast basin/depression,

extending from the Shackleton Ice Shelf to Vincennes Bay, departs under the Bond, Adams and Vanderford Ice Tongues in the southeast direction. On Wilkes's Land under the Moskovskiy Universitet and Voyeykov Ice Shelves, is reveal/detected narrow depression with depths more than 1000 m, that was lengthened along shore at a distance more than 500 km. To the south from the uplift/rises in which are held the glaciers pointed out above, stretches vast basin/depression with depths more than 1000 m. The south boundary of depression is not establish/installed. One should assume that this depression, being stretched to west, it is connected with the under-ice basin/depressions, detected on route Mirnyy-Vostok. In the east this series of basin/depressions is connected with deep depression (with depths more than 1000 m), lengthened along shore of Adelie Land for extent/elongation more than 500 km, and with the series of deep basin/depressions to the south of station Dumont-d'Urville.

The fault of crust in shelf zone, traced from 108 to 80° east longitude, emerges at the western edge of West Ice Shelf in the form of trench and has south-west strike/course, i.e., it goes in direction to the east part of Prydz Bay. The marks of the depths of basin/depressions

of the edge of Western glacier are approximately 1000 m, and on 81.3° east longitude is reveal/detected basin/depression with encdepth of approximately 1800 m.

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Of the former edge of the Amery Ice shelf, in east part, its marks reach depths 800 m. In 1964 a marine detachment of the 10th SAE (Ledenev, Yevdokimov, 1965) reveal/detected that the edge of glacier was broken off for extent/elongation 100 km. Was displaced approximately on 18 km and the boundary of Polar Record Glacier. The measurements, made on the section, earlier enclosed by glacier, showed depths 720-850 m of east edge even 400-500 m of western (in region of the former Cape Amery). Is noted the large jump/drop in the depths along northern and the metric definitions, made into 1956-1957 from the former edge of the Amery and Polar Record Glaciers, confirm these data.

Isobath 500 m delineates the vast basin/depression of Prydz and MacKenzie Bays. In the east part of the basin/depression, are planned two branches - northeast in the direction of the depression, which emerges from under

the West Ice Shelf, and south-west, in direction of which the basin/depression departs under Amery Glacier. Its continuation, obviously, is Sandefjord Bay. It is possible, one of the branching of vast basin/depression pointed out above stretches under the western edge of Amery Glacier. However, measurements of 10th SAE, made after truncation of glacier, in this part of the glacier did not reveal/detect considerable depths. The marks of the bottom of sea there do not exceed 400-500 m.

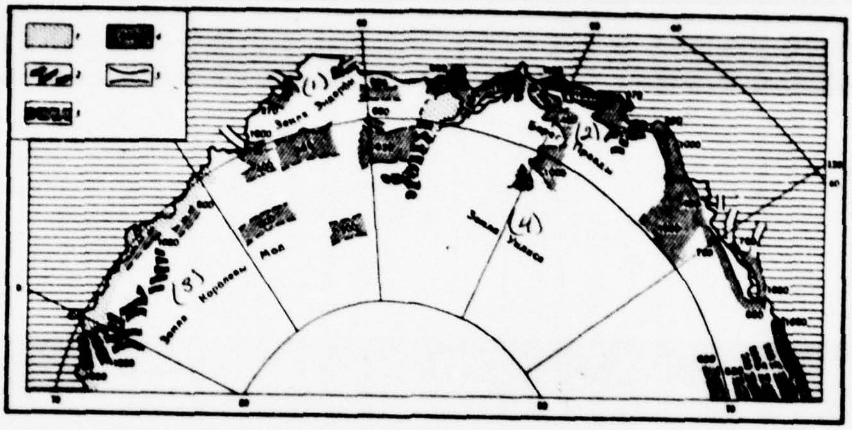

Fig. 24. Circuit of sublatitudinal trenches of limb zone of east antarctica. Compiled by P. A. Stroyev. 1 - shelf glaciers; 2 - leading-out and intermountain glaciers; 3 - basin/depression of trench; 4 - mark of maximum depths, m; 5 - depression of shelf, opened by sonic measurements.

Key: (1). Enderby Land. (2). Pravda Coast. (3). Queen Maud Land. (4). Wilkes Land.

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A sharp reduction in the heights of the surface of mainland glacier from 2000-1500 m of the edge of Lambert leading-out glacier to 900-200 m on its surface, and the

north from the 72nd parallel to 100-50 m is led to the conclusion that the bed of Lambert Glacier is located below sea level, i.e., as the river bed of leading-out glacier serves deep depression. As confirmation this serves the considerable speed of leading-out glacier. At a distance 300 km and more of the edge of glacier its speed exceeds 400 m/Year, while at a distance of approximately 100 km, it is close to 1000 m/year. In this respect Lambert Glacier is not the exception/elimination: deep basin/depressions from 1000 to 1400 m are reveal/detected under all investigated geophysicists by the leading-out glaciers of antarctica, as for instance, Denman, Mertz, Ninnis Glaciers, etc.

P. S. Voronov assumes that under Lambert and Amery Glaciers is arrange/located the grabenlike depression, possibly, stretching from Prydz Bay to south pole or perhaps that intersects entire continent. By works 9th SAE is establish/installed (Kapitsa, Sorokhtin, 1965), that this basin/depression does not have an outcrop to the south (southr than 80° south latitude).

The discovered by Australian researchers intracontinental basin/depressions to west from Lambert Glacier on meridians 62.2 and 60.8° east longitude between 68-69° and 70-72°

south latitude with the marks of depths to -900 m have east-west strike/course. These basin/depressions, apparently, and are the continuation of fault concealed/latent under Amery and Lambert Glaciers. Its continuation in west revealed 9th SAE on section 69.8-71.8° south latitude and 41-46° east longitude, where is reveal/detected the vast basin/depression of east-west strike with the marks of depths of approximately 600 m, and can be, and it is deeper.

Luetzow-Holm Bay far submerges into shore, his south boundaries thus far are not establish/installed. So, Japanese expeditions to the east from 40° east longitude establish/installed the presence of the basin/depressions with depths from 400 to 1000 m, which were being communicated with Luetsow-Holm Bay. Apparently, the northern branch of this vast basin/depression goes to Luetsow-Holm Bay. However, according to the available data further at sea it is not outlined, although region of shore to west from 40° east longitude is barely studied. The basic branch of depression, probably stretches to west-southwest northern Yamato Mts. and passes along shores of zone to Princess Ragnhild Coast.

To the south of Yamato Mts. it is reveal/detected (?)

under-ice valley with the ground elevation of stone rock/species or vast basin/depression with depths to 1000 m. If this then, then the depression, discovered 9th SAE, is continued for the basin/depression south of Yamato Mts. and departs to the west south of mountain ridge/range of Queen Maud Land. This fact deserves attention, since it indicates the presence in the intra-mainland antarctic plateau of deep basin/depressions - the faults of the earth's crust, which are pulled in sublatitudinal direction in parallel to shore and the mountain system of Queen Maud Land. The discovered by aeromagnetic photographing system of under-ice mountain ridges southern band of mountains on Wegenerisen Plateau (to the south from mass of Wohlthat) confirms this assumption.

At region of Roi Baudoin Station the bedrocks lie/rest below sea level on the average depth of approximately 300 m. "True shore" is located at a distance 150 km of the edge of shelf glacier.

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In some places of the basin/depression of under-ice bed, they reach depths 500 m and more. These depression are stretched in parallel to shore and in west depart under Lazarev Ice Shelf.

In region of Lazarev Ice Shelf by geophysical methods was revealed the vast basin/depression (Frolov, Koryakin, 1960; Bokananko, Avsyuk, 1963) of the east-west strike/course with the depths, exceeding 1000 m which departs further to west under the Fimbulisen Glacier.

Still further to west a Norwegian-British-Swedish expedition 1949-1952 (Giaver, 1954), which performed the investigations of under-ice relief in route 600 km of the Maudheim station for the southeast, it reveal/detected a series of deep (more than 1000 m) and vast (50-100 km) basin/depressions, stretching to southwest to the northeast. It is possible, these basin/depressions are also the part of the sublatitudinal fault in question and depart further to southwest to Coats Land. At Coats Land the orientation of trenches is changed. It is there reveal/detected two trenches with depths more than 800 m, that have direction from the northwest to the southeast and exiting under mainland glacier. Together with the considerable trench of the east part of the Filchner Ice Shelf whose depths reach 1200 m, this system of the faults of the earth's crust departs in meridional direction, separate/liberating the

structures of east-antarctic platform from the Alpine downwarp/troughs of Western antarctica.

Thus, the geophysical studies of the under-ice relief of the sections, closed by shelf glaciers, confirm conclusion about the fact that the basic distinctive morphostructure of the shelf seas of east antarctica is their cutting deep trench, named Lazarev Trench, who is outlined on the periphery of continent. However, this trench, having in essence sublatitudinal strike/course, on some sections it is interrupted by submeridional morphostructures. On some sections Lazarev Trench is several sublatitudinal depression, as a rule, which are stretched in parallel to each other and configurations of continent.

Some geophysicists and geologists (P. S. Voronov, A. V. Zhivago, Ya. P. Koblentz, A. P. Lisitzin) assume that this system of the basin/depressions of sublatitudinal strike/course forms single trench with depths from 500 to 2000 m which is stretched around entire Antarctica and divides shelf into two parts: circumlittoral and oceanic. The formation of trench or fault of crust is joined with with glacio-static motions of crust, caused by alternations in the glacier load of continent to quaternary time. Other

researchers (Ye. S. Korotkevich, A. F. Treshnikov) deny the presence of single trench and they consider that the observed depression of the bottom of sea both sublatitudinal and submeridional strike/course are the local formations, which do not present single system. The origin of these faults they join with the tectonic motions of mainly pre-Quaternary period.

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What present themselves the discovered basin/depressions and the trenches: single trench either the fault of crust, which was subjected after formation to considerable changes, or the system of the faults whose formation was caused by single reason, this question is not fundamental. There are no foundations for asserting that the formed around Antarctic continent under the action/effect of ice load single fault was not subjected to in the subsequent epochs disjunctive changes as a result of the various kinds of the motions of crust. The system of sublatitudinal faults girds entire continent Antarctica, what is not observed on other continents, i.e., trench is the characteristic feature only of shelf seas of Antarctica (Voronov, 1958) and is absent from the shelf seas of other continents. Since

Antarctica is characterized by in principle from other continents only contemporary glaciation, it is possible to be connected to the opinion of the researchers (A. V. Zhivago et al.), that consider that the presence of trench as caused by glaciostatic otions of the earth's crust. The reason for the formation of these trenches or faults, obviously, single is oscillatory motions of the earth's crust under the action/effect of ice load, i.e., laciostatic motions.

The analyses of the isostatic state of the crust of antarctica (S. A. Ushakov, G. Ye. Lazarev, A. I. Frolov) showed that the enormous increment load of ice on continent in essence was compensated for (by 80-90o/o), which is possible only as a result of downwarp/trough or upwarp of crust. The downwarp/trough of crust had to cause the displacement of subcrustal masses from under the central regions of glaciation to limb zone. As a result of these motions in limb zone, were formed the faults of crust, faults and uplift/rises. Since the processes of intense freezing and departure of glacier in quaternary time passed repeatedly, the earth's crust of continent test/underwent the considerable periodic bouncing which created the block tectonics of the limb zone of Antarctica.

However, some lines of the contemporary configuration of Lazarev Trench, probably to a considerable degree are caused by the character of more ancient faults. Furthermore, the presence of submeridional structures on some sections, which substantially level and even which interrupt themselves trench, attests to the fact that the relief of shelf zone is caused not only by low glaciostatic, but also tectonic motions.

The geologic and geophysical investigations of the circumlittoral part of Antarctica made it possible to establish that for an entire peripheral zone of east Antarctica are very characteristic the different faults. Along with ancient faults are very widely common young, many of them repeating the main directions of ancient faults. For an entire this zone of east Antarctica, are characteristic two directions of the newest faults: in parallel to the configurations of continent it is perpendicular to them. It is establish/installed also that and in shelf zone the relief of the bottom to a considerable degree is caused by the disjunctive dislocations as a result of which was formed the characteristic for east Antarctica shelf of very complex structure and strongly separated.

east Antarctica shelf of very complex structure and strongly separated.

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Conclusion

The basic results of the conducted by us investigation consist in the following.

1. In period and after IGY experiments of south ocean and Antarctica exceeded investigations of entire preceding period of research on this region of terrestial globe. In the complex of these investigations the considerable role occupies research on gravitational field. At the present time by Soviet and foreign geophysicists in the south ocean and the Antarctic is made the considerable volume of gravimetric investigations.

2. According to data of gravimetric studies, are comprised schematic gravimetric map/charts of south ocean and circumlittoral zone of Antarctica. Gravitational field clearly record/fixes the basic morphostructure cell/elements of the relief of the bottom of ocean and boundary/edge part of

the Antarctic continent. The vast minima of the anomalies of the force in all probability characterize regions with the lowered/reduced density of the substance of mantle. These anomalous zones are confirmed by the magnetic anomalies, by the excesses of geoid and by other facts. Gravity anomalies on Antarctic continent clearly record/fix changes in the relief of the stone rock/species of the bed of glacier, they make it possible to isolate the separate block/module/units of the earth's crust, characterize the special feature/peculiarities of the structure of the earth's crust and upper mantle.

Judging by character and value of gravity anomalies, the earth's crust of the south ocean and Antarctics is isostatically compensated for. Are separate/liberated the uncompensated sections of these zones (island arc, the block mountain of the periphery of the continent of Antarctica).

3. Statistical relationship/ratios of depth of Moho surface and gravity anomalies, determined for south ocean and Antarctic, made it possible to construct circuit of earth's crust of these zones. The isolines of Moho surface clearly record/fix the basic morphostructure special feature/peculiarities of the structure of the relief of the

bottom of ocean and transition zone of Antarctic continent. Deep-water oceanic basins have fine/thin crust as thickness 5-10 km, underwater ridges are characterized by an increase in the thickness of crust to 15-20 km. Under island arcs the crust has continental type signs, thickness its 20-25 km. The interpretation of gravimetric data for mid-oceanic ridges is given in two versions: for the normal and anomalous density of upper mantle. The statistical relationship/ratios of the power/thickness of crust and anomalies of the force for rift zones indicate to completely different, the peculiar type of the earth's crust, sharply different from continental and oceanic types.

Are revealed the regional special features of the structure of crust and mantle of the Atlantic sector of south ocean.

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Probably that the upper layers of mantle in this region are less uniform in density, at least in Pacific Ocean. Furthermore, is explained the complexity of the earth's crust and upper mantle at Scotia Sea and Drake Strait. There are the foundations for relating them to the "Pacific Ocean" type of crust and mantle.

In transition zones from ocean to continents, the thickness of the Earth's crust sharply is increased approximately from 15 to 35 km. The crust of these zones is presented by the series of block/module/units. The boundaries of block/module/units pass along faults.

Continent Antarctica has the continental type of crust. In east Antarctica the thickness of crust is equal to 35-40 km and is increased to 45-50 km under mountain masses. In Western antarctica the thickness of crust is 25-30 km and also it grow/rises under mountain rests to 35-40 km.

In transition zone of Antarctica, the thickness of crust is changed very sharply, the boundaries of the block/module/units of crust pass along faults. In the shelf zone of Antarctic continent, it is reveal/detected by break in the terrestrial core, the so-called Lazarev Trench, which is stretched in parallel to mainland at a distance is more than 8000 km. Its formation is joined with the oscillatory motions of the earth's crust under the action/effect of ice load. Glaciostatic motions even more contributed to the breaking up of the crust of Antarctic platform and created its block-laminated tectonics, which finds its reflection in the field of gravity anomalies.

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